POWER

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The Man and the Job

SEVERAL of these forewords dealing with qualifications for getting on in power-plant engineering have brought me a lot of correspondence from men who are not doing as well as they feel they ought to.

I do not know of a better service that *Power* could render to its readers than to bring together the man who has outgrown his environment, who is capable of assuming greater responsibilities than his present position offers, or who finds himself out of employment, and those who are looking for desirable engineers.

It has been a pleasure to perform this service in a considerable number of instances, and we would like to do more of it.

If you have an opening for an engineer who is trying to get on, who has a creditable record of experience and results obtained and aspirations for greater opportunities, let us know what kind of a man you want and what you can offer him in the way of prospects and pay. It is more than likely that we can find him for you.

If you are looking for a position, let us know what kind of a position you want and believe that you can handle. Give us an outline of your experience, the kind of work that you have been and are doing, the records that you have made, especially of savings and improvements; your age, educational equipment, especially as regards engineering, limitations as to where you would go, your plans and ambitions and expectations as to salary, immediate and prospective.

But do not, unless you have exhausted the opportunities of your present position, look for a change simply for the sake of changing. The chance for which you are looking may lie at your door. Give the best that is in you to your present employer and your present job. It may be that it will develop into something bigger and better.

If it does not, you will; and if your larger service is not appreciated, or if you see no future in your present position, let us know what you have done and we will try to find you a better chance.

F. R. Low

Repair of Mammoth Vertical Compressor Engine Cast Iron Cylinder

By A. M. CANDY,
General Engineer, Westinghouse Electric and Manufacturing Company

Two cracks, 3½ and 5 feet long, respectively, were successfully closed. Welding operations cost about 10 per cent of the price of a new cylinder, besides eliminating a long shutdown.

THE engine is of the independent compound vertical type, the two units being mounted side by side. The steam cylinder is mounted at the lower end of each unit and the air-compressor cylinder at the top. The pistons for the steam cylinder and the compressor cylinder are mounted on a common piston rod. The flywheel for each unit is about 18 ft. in diameter and the total height of each unit is approximately 40 ft. The stroke is 60 in., whereas the bore of the high-pressure steam cylinder is 44 in. and the bore of the low-pressure cylinder 80 in. Each unit will develop about 750 hp. at 44 r.p.m., pumping against an air pressure of 15 lb. per sq.in. This is a total of 1,500 hp. for the two units of the independent compound engine. They are rated at 2,000 hp. by the manufacturer and are actually capable of pumping against an air pressure of 35 lb. per square inch.

The piston assembly of the low-pressure steam cylinder became damaged owing to the follower plate on the piston head becoming detached and skewed at an angle with the piston rod. Before the engine could be stopped, this plate struck the upper head, breaking it, as well as the piston and packing rings. The broken parts dropped on the lower head. When the piston reached its downward stroke, the lower head was broken in a number of pieces and the lower end of the cylinder was cracked on one side a distance of about 3½ ft., as illustrated in Fig. 1 outside, and Fig. 2 inside of the cylinder. The lower end of the crack passed directly through the hole for one of the cylinder-head bolts. The opposite side of the cylinder, Fig. 3, was cracked a distance of about five feet.

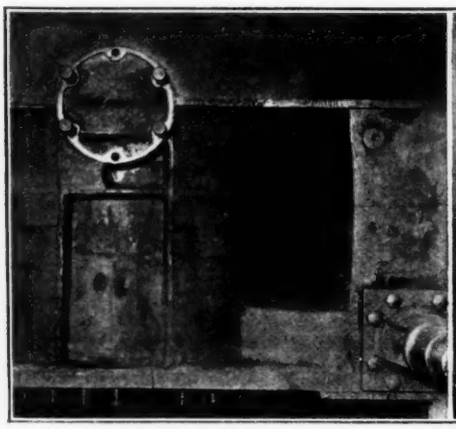

FIG. 1—LOWER CYLINDER CRACKED

FIG. 2—INSIDE OF SAME CRACK

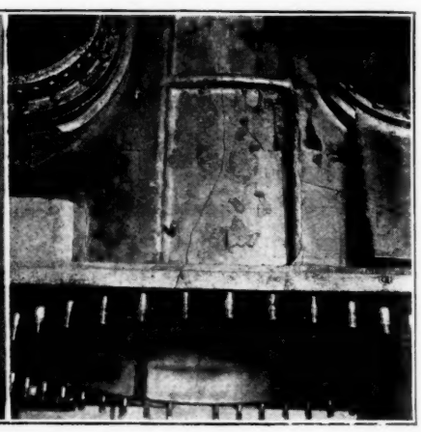

FIG. 3—DAMAGED OPPOSITE SIDE

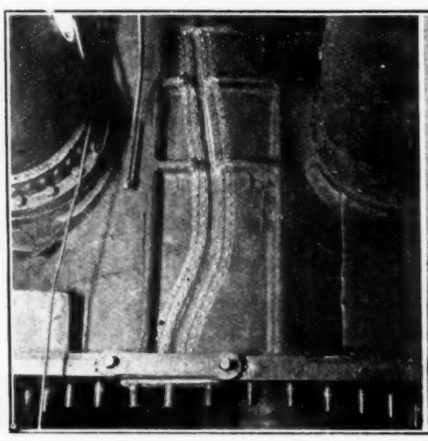

FIG. 4—CRACK CLOSED AND PREPARED

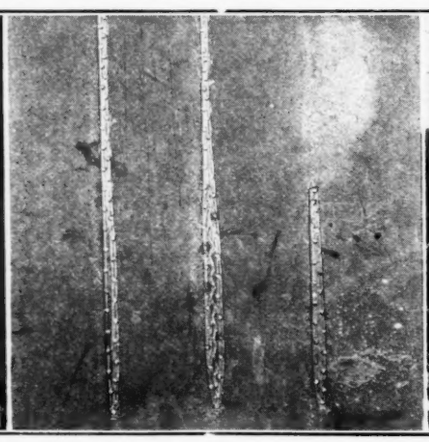

FIG. 5—SCORES CHISELLED AND PLUGGED

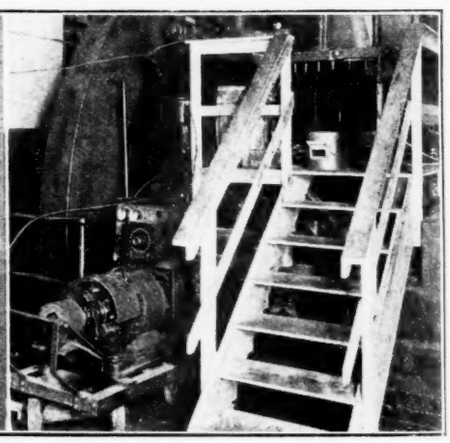

FIG. 6—WELDING ARRANGEMENTS COMPLETED

Upon dismantling the piston assembly, the cylinder wall was found to be badly scored the full length of the 60-in. stroke. There were three of the score marks

on one side of the cylinder and two on the opposite side. The worst of these scores was about 2½ in. wide and about ⅜ in. deep. These marks, however, were not the result of the accident, but were formed during normal operation of the engine caused by the accumulation of foreign particles in the cylinder. This was evidenced by the smooth surfaces of the scores.

The cost of a bare cylinder casting at the time of the accident was estimated at approximately $12,000. To dismantle the engine and install the new cylinder would probably bring the total to about $15,000. The shortest delivery date for a new cylinder was eight to nine months. This naturally led to the consideration of repair by welding not only as being less expensive, but also as decreasing the length of time the engine would be out of service.

When the cylinder broke, the cracks opened up about one-quarter of an inch at the lower end. The first problem, therefore, was to devise a way to draw the two halves of the cylinder back to their original positions, so that the cracks would be closed up. To accomplish this, two stud bolts, 1¼ in. in diameter, were placed in the edge of the flange, one on each side of the crack, as in Fig. 4. Two similar bolts were placed in the edge of the flange at the opposite side of the cylinder, one bolt on each side of the other crack. Two steel links were made, one of which was shrunk on over the cylinder head studs and the other over the 1¼-in. studs as follows: The upper bar was heated red hot, placed over the cylinder-head studs and allowed to cool. The lower link was then shrunk on the vertical studs, which drew the crack together sufficiently to allow the upper bar to be removed. It was then upset or shortened the proper amount, heated, placed over the 1¼-in. studs and allowed to cool, thus drawing the parts closer together and relieving the lower bar. This cycle was repeated on both sides until the cracks were practically closed. The cylinder was then rebored one-half inch larger in diameter so as to partly eliminate the scores in the cylinder wall. This reduced the thickness of the wall to between 1½ and 1⅝ inches.

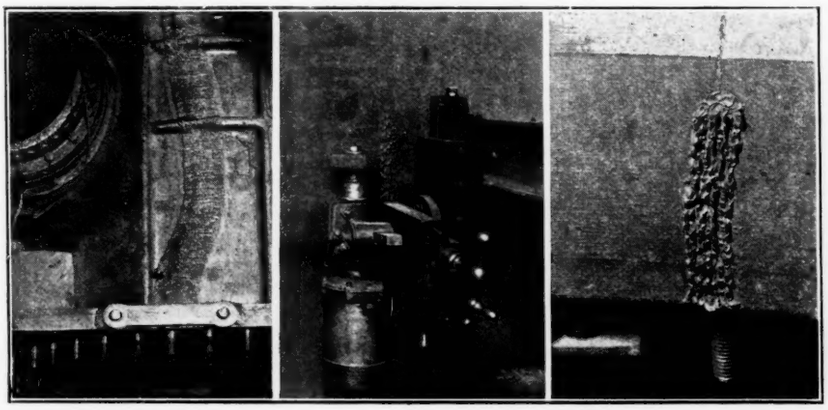

FIG. 7—FIVE FOOT CRACK WELDED

FIG. 8—GRINDING FILLED SCORES

FIG. 9—CRACK FILLED IN BORE

The next step in the operation, shown in Fig. 4, was to cut out both cracks to form a V-groove of 90-deg. angle, three-fourths of an inch deep, and clean off the surface of the cast iron along the sides of the groove to a distance of about four inches. Holes were then located on 1½-in. centers along these cleaned surfaces, which were drilled and tapped for ½-in. bolts. These were cut off, leaving one-quarter inch extending beyond the surface. A total of 136 bolts (studs) were required for the long crack, Fig. 4, and 116 studs for the short crack, Fig. 1. A few studs were also located around the top edges of the shrinkage links so they could be permanently welded in position.

The next step was to chisel grooves about one-fourth inch wide and deep between the rows of studs and along the center of the beveled edges next to the cracks, as shown by Fig. 4. This completed the preparation of the cylinder for the actual work of welding.

The first step in the welding work was to deposit metal very carefully in the grooves just mentioned by means of electric current, so as to obtain the best union possible. The object of these grooves is to increase the length of the steam-leakage path and to concentrate the attention of the operator on making at least one exceptionally good string of deposited metal. The operator then began to put down strings of metal in the V-grooves running lengthwise of the cracks. Sufficient numbers of strings were deposited to make the surface of the deposited metal about flush with the outside surface of the cylinder.

The operator put down a string of metal very carefully around the end of each stud next to the cast iron, so as to tie each stud to the cast iron as well as possible. The next step was to pad over the entire cleaned surface of the cast iron between the studs on both sides of the strings built up in the V-groove. The direction of these padding strings was at right angles to the crack. To keep the localized heating at a minimum, the operator did not start at one end and work progressively toward the other end of the crack. The work, instead, was done in sections, putting down one string of metal at one section and then passing to another some distance from that just worked on. This plan was carried out during all the subsequent welding. Fig. 7 shows these sections quite clearly, as the final string of each section is easily visible.

To facilitate welding, the scores inside the cylinder were cut out deeper and studded, as illustrated by Fig. 5. Fig. 8 shows the appearance of the metal deposited in the scores and of the surface when ground to conform quite closely to the bore of the cylinder, as well as the rigging for grinding. This same equipment was used to grind the bore of the cylinder surrounding the lower end of each crack as illustrated by Fig. 9. The cylinder wall was sprung in a maximum of about $\frac{3}{32}$ in. at the bottom end of each crack, caused by the contraction of the deposited metal on the outside of the cylinder wall.

In all the welding work the operator observed every precaution to maintain the temperature of the parts at a minimum so as to reduce the cooling strains and distortion. All the first strings of metal in contact with the cast iron were put down with extreme care because the casting is a very poor grade for welding, being a very gray grade of cast iron, containing a high percentage of free or graphitic carbon.

After completing the work, as already described, the

broken upper head was prepared and welded in a similar manner. No photographs were taken, however. The lower head was broken into so many pieces in the accident that no attempt was made to reclaim it. A new casting for replacement was ordered shortly after the accident.

The same operator did all the work of preparation, welding and finishing, requiring a total of 327 hours. To arrive at an approximate cost of the entire job, as well as time and labor, the data in Tables I and II will be of assistance.

TABLE I—ITEMIZED LIST OF TIME AND MATERIAL

Parts Repaired	Time in Hours Required for Preparation: Chipping and Grooving	Drilling, Tapping and Setting Studs	Number of Studs Required and Diameter in Inches	Time in Hours Required for Welding	Pounds of Welding Wire Used	Time in Hours Required for Grinding
3½-foot crack	13	21	116 ½	44	45	..
5-foot crack	21	25	136 ½	68	76	..
Score marks	4	12	184 ⅜	8	8	24
Head	22	26	250 ½	39	40	..
Totals	60	84	602 ½ 184 ⅜	159	169	24
Grand time total	327					

TABLE II—GENERAL ESTIMATE OF WELDING COST

Labor at 90c. an hour	$295.00
Bolts ¾-in. at $1.55 and ½-in. at $2.35 per 100	17.00
Welding wire at 9c. per pound	15.20
Reboring cylinder	400.00
Miscellaneous—electric power for welding set, grinding wheels, etc.	10.00
Total	$737.20

From the figures in Table II it can be seen readily that even if a reasonable overhead charge is added, the total cost would not exceed 10 per cent of the bare cost of a new cylinder, which does not include the additional expense involved in removing the old cylinder and installing the new one.

Submerged Orifices for Uniform Control of Chemical Feed

To improve the accuracy and uniformity of control of the chemical feed in proportion to the quantity of water entering a continuous water softener, the Graver Corporation, of East Chicago, Ind., has replaced the system of weirs formerly used, with a divided-flow system employing submerged orifices. Reference to the illustrations will show the arrangement.

In order to understand more clearly the function of the orifices, brief reference will be made to the principle upon which the feed operates. Raw water enters the elbow *H* through the pipe *P*, Figs. 1 and 2, and overflows chamber *C* into the downtake. Chamber *F*, supplied with raw water through pipe *I*, serves as a sort of relay, its flow bearing a definite relation to that in the large chamber *C*. The overflow from *F* goes to the control tank, which contains a float connected through a chain *T* to a swing pipe in the chemical tank. As the control tank fills, the float rises, allowing the swing pipe to descend and feed uniformly the chemical into the downtake leading to the settling tank. Here it mixes with the water overflowing spillway *D*, and the mixture eventually reaches the concentric space in the settling tank surrounding the downtake.

The two orifices *A* and *B*, Fig. 2, bear a fixed relation to each other. Water passing through the larger orifice *A*, fills the chamber *C* and overflows the spillway *D* to supply the softener. That portion of the water passing through orifice *B*, discharges over the spillway *E* in chamber *F*, and through pipe *G* gravitates to the control tank. Nozzle *B* is proportioned so that under a fixed head it will fill the control tank in twelve hours. The head over the smaller orifice is made equal to the submergence *K* of orifice *A* by adjustment of the pipe nipple *J* at the time the softener is placed in operation.

With both orifices discharging under water in a solid stream against the same back pressure, with any change in flow affecting both orifices similarly, and with no chemicals, such as hydrated lime, passing through either orifice to form a deposit, it is claimed that uniform and accurate proportioning is maintained indefinitely.

In the settling tank a further refinement has been introduced in the form of a rate-control orifice *L*, Fig. 1. This is an opening in the softener outlet pipe which discharges the rated capacity of the softener under a head of 6 in., the head being controlled by a float valve on the raw-water inlet line. When placing the softener in operation, the water level is adjusted

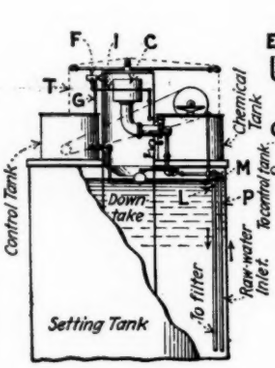

FIG. 1—CONTINUOUS WATER-SOFTENING UNIT

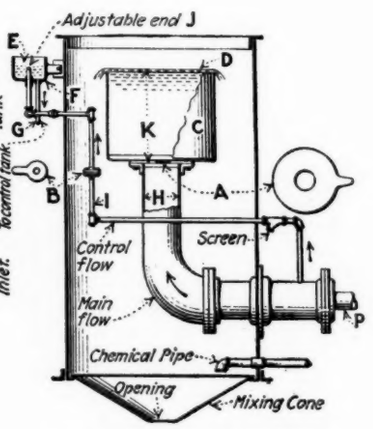

FIG. 2—DETAILS SHOWING DIVIDED-FLOW ORIFICE SYSTEM

to the mark *M* on the outlet pipe. Any movement of the water level above this mark will close the float valve, and when the supply becomes less than the demand, so that the water level falls below the mark, the float valve opens until the water level is brought back to normal. The outlet pipe extends to the top of the settling tank, and being above the water line, is open to the atmosphere, so that if a pump were attached to the outlet, the water level in the settling tank could not be lowered farther than the bottom of the orifice.

I have met all kinds of firemen, but I have yet to see the man who cannot understand the purpose and use of boiler-room instruments, provided it is only explained to them in the way that they can understand. On the other hand, it is human nature to slip back unless prodded on. There is no royal road to boiler-room economy, no short cut and no mystery. It is attained by the constant and intelligent and systematic application of a few common-sense principles and by keeping everlastingly at it.—*J. T. Beard, 2nd, in Industrial Management.*

The loss of head in a 1½-in. gate valve, at a velocity of 6 ft. per sec., for water, is 11 ft. when one-quarter open, 3.8 ft. when three-eighths open, and 1.6 ft. when one-half open. When three-quarters and full open the loss is less than one foot of water.

Reconnecting Direct-Current Machines—Changes in Voltage—II

Reconnecting a 250-Volt Machine for 125 Volts, a 125-Volt Machine for 250 Volts and a 110-Volt Machine for 550 Volts

By A. C. ROE*

CONSIDER the problem of reconnecting a four-pole 10-hp. 250-volt 1,200-r.p.m. shunt-wound motor for 125 volts. The armature is lap wound with 60 coils, each of 5 turns of one No. 14 d.-c.-c. wire. The coil pitch is 1 and 16 and there are 60 bars in the commutator. Fig. 1 shows a section of the winding and commutation. This winding could be changed to a double-lap, or eight-circuit, by lifting all the top leads and making the connections one and three, Fig. 2, instead of one and two, Fig. 1. One and two mean that the top and bottom leads of the same coil connects to adjacent segments. For example, the leads of coil 50, Fig. 1, connect to segments 49 and 50. The one and three connection is one in which the top lead connect to the adjacent segment plus one from the bottom lead of the same coil. In Fig. 2 one lead of coil 50 is connected to bar 50, where the other lead connects to bar 48 instead of 49, in Fig. 1. With the single-lap connection there is one circuit through the winding from one set of brushes to the next. In Fig. 1 between the brushes on segments 45 and 60 there is one series of coils; namely, through coils 46, to 60, on 15 coils in series. With the double-lap connection, Fig. 2, the brushes must be wide enough to cover at least two segments at all times as in the figure. With this arrangement it is seen that there are two circuits of

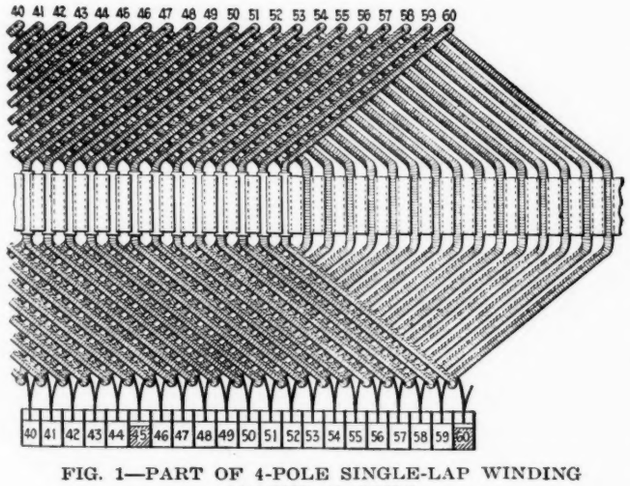

FIG. 1—PART OF 4-POLE SINGLE-LAP WINDING HAVING 60 COILS

coils in parallel. For example, from brush *A* the circuit is through coils 46 and 47, then through coils 48 and 49 until the circuits are completed on brush *B*. In this figure there are one-half the number of coils in series between the brushes, as in Fig. 1, therefore the winding is good only for one-half the voltage. Since there are two circuits between brushes in Fig. 2, this winding can carry double the current of the single-circuit winding, Fig. 1, consequently both windings will have the same power rating.

The only other method of changing this armature from 250 to 125 volts is to rewind all the coils with

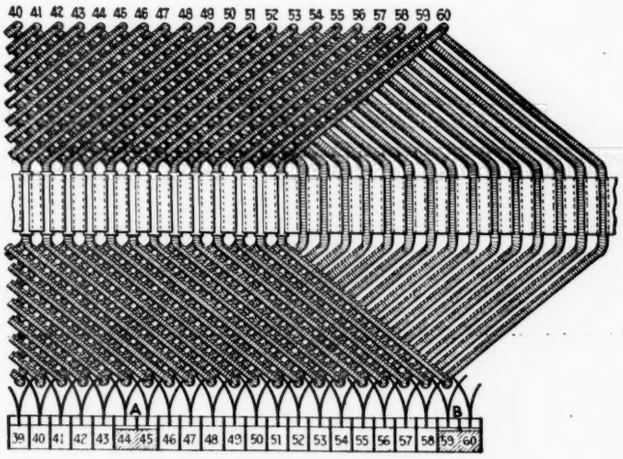

FIG. 2—WINDING FIG. 1 CONNECTED DOUBLE LAP FOR ONE-HALF VOLTAGE

one-half the number of turns having copper double the size. Each coil has 5 turns; then $5 \div 2 = 2\frac{1}{2}$ turns. A half turn is impracticable, and as there are 60 slots and coils, 30 coils could be wound with 2 turns of two No. 14 wires in parallel and 30 coils with 3 turns of two No. 14 wires in parallel. The coils in the original winding are wound full pitch, 1 and 16, and if the new winding is wound with the same pitch, it will bring one side of a 3-turn coil in the same slot with a 2-turn coil, as indicated in Fig. 3. In the figure one side of coil 43, which has two turns, falls in the same slot with coil 58, which has three turns. Then since each slot contained ten No. 14 wires in the original winding, the new winding, which also has 10 No. 14 wires per slot, can be put on the core. The armature will have to be wound with a two- and a three-turn coil alternately for the arrangement to come out correctly. In Fig. 3 the number of turns per coil is indicated at its lower end, as 2, 3, 2, 3, etc. Each coil will have two pairs of leads so there will be four leads connecting to each segment. When making a bar-to-bar test on this winding with a millivoltmeter, alternate low and high readings will be obtained with the low reading about two-thirds the value of the high when the coils are not defective.

This last method of changing the winding brings up another point that should be checked before changing any winding from a single-lap or wave, to a double lap or wave connection. First check the coils to de-

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termine if they all have the same number of turns. If they have not, the coils cannot be connected in parallel; that is, the winding cannot be changed to double lap or wave, since the resistance of the two parallel paths would be unequal and circulating currents would flow, resulting in heating.

In the foregoing case, if it had not been possible to change the turns in the coils to get the equivalent of $2\frac{1}{2}$ turns per coil, the only other course would have been to drop the half turn on each coil. There would then be 60 coils of two turns or 120 turns, instead of $60 \times 2\frac{1}{2} = 150$ turns. This is $(120 \div 150) \times 100 = 80$ per cent of the required number of turns, and would increase the speed of a motor 20 per cent and decrease the voltage of a generator 20 per cent. In the case of a generator, if belt-driven the pulley could be changed to increase the speed 20 per cent, which would bring the voltage back to normal. With a motor the pole-pieces could be skimmed down to decrease the air gap and thus strengthen the field and reduce the speed. The reduction obtainable might not be so much as 20 per cent, but would be enough to make the winding change passable. In this case, since the motor has four poles and the voltage is reduced by one-half, the field coils can be connected series parallel, as explained in the previous article, for 125 volts.

Changing 110-Volt Motor to 220-Volt

Another case, say it is desired to change a 110-volt motor to 220 volts and that it is compound wound with interpoles, and the armature is wave wound with single-wire coils, there being 53 slots and commutator bars. As the voltage is to be doubled, the turns in all the field and armature coils must be doubled and the cross-section of copper reduced one-half. This means that the shunt, series and interpole coils will have to be rewound. The shunt coils are easily rewound, as this

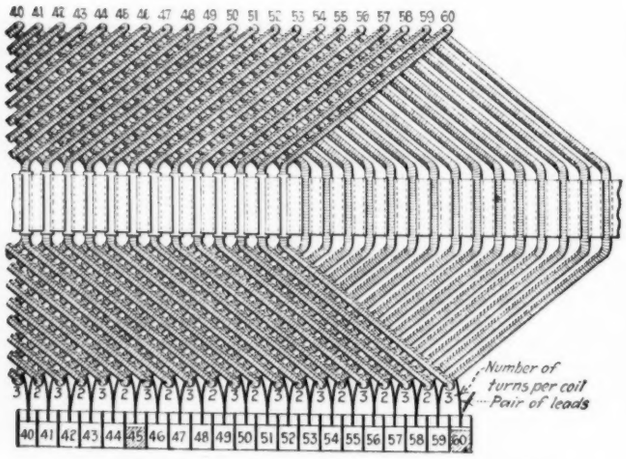
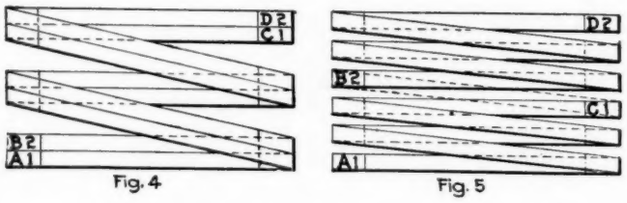


FIG. 3—WINDING FIG. 1 CHANGED TO ONE HAVING ALTERNATE TWO- AND THREE-TURN COILS

type of coil uses a small round wire. On large machines the series and interpole coils are wound with strap copper bent on edge, and in some cases two straps in parallel are used. When the latter is the case, it is an easy matter to separate the sections, put one on top of the other and connect the two in series, which doubles the turns and halves the cross-section, as indicated in Figs. 4 and 5. If the coils are wound with a single strap, the only remedy for a small shop would be to select a number of square wires to give the cross-section required and arrange them to the best advantage in the space available, as in the following example, where it is desired to change a 15-kw. 125-volt 120-ampere 600-r.p.m. 4-pole compound-wound generator to 250 volts: The series coils have $7\frac{1}{2}$ turns of one $\frac{2}{16}$ x $\frac{8}{16}$-in. copper strap bent on edge; each shunt coil has 695 turns of one No. 12 d.-c.c. wire arranged in 24 layers, 15



FIGS. 4 AND 5—SHOW HOW A 110-VOLT COIL WOUND WITH TWO STRAPS IN PARALLEL MAY BE MADE GOOD FOR 220 VOLTS

layers of 30 turns per layer, 2 layers of 29 turns, 2 layers of 28 turns, 2 layers of 27 turns, 2 layers of 26 turns, and one layer of 25 turns, giving a tapered coil. The armature is wave wound, having 47 slots and bars, coil pitch 1 and 11, lead pitch 1 and 25, 47 coils, 2 turns of two No. 7 wires in parallel, 4 wires per bar. As this machine is to be changed for twice the original voltage, the turns in the field and armature coils must be doubled and the cross-section of copper decreased one-half.

Calculating the series coils first, the turns equal $2 \times 7\frac{1}{2} = 15$, but one-half turn more or less will have to be used to make the leads come out correctly. The size of the copper in the series coils will equal $\frac{8}{16} \div 2 = \frac{8}{32}$ for one dimension and $\frac{2}{16}$ in. for the other, or a strap size expressed in decimals equal to 0.093x0.563 in. It is required to bend this strap on edge, and as there are 15 turns per coil, it would be an expensive job. Consulting Table II it will be found that a No. 11 square wire has a bare diameter of 0.0907 in., which is close enough for the thickness of the conductor, and six No. 11 wires have a total width $6 \times 0.0907 = 0.544$ in. Then the series coils can be wound with 15 turns of six No. 11 d.-c.c. square wires in parallel. In a case where such a job was done, each turn was well painted with liquid Bakelite while winding and the complete coil baked, which made a solid coil with good heat-radiating qualities.

Each shunt coil will have $2 \times 695 = 1{,}390$ turns for 250 volts. No. 12 round wire, as used in the 125-volt coils, has a cross-sectional area of 6,530 circ.mils. Then the wire size for the new coil equals $6{,}530 \div 2 = 3{,}265$ circ.mil, or one No. 15. The diameter of a No. 12 d.-c.c. wire is 0.091 in. and that of No. 15 d.-c.c., 0.066 in., which means that the turns per layer will have to be rearranged. The original coils had 15 layers of 30 turns per layer, or $30 \times 0.091 = 2.73$ in. Then the turns per layer for the new coil are $2.73 \div 0.066 = 41$ turns. Fifteen layers of No. 12 wire equals $0.091 \times 15 = 1.365$ in.; then the number of layers of No. 15 wire that can be put in this space is $1.365 \div 0.066 = 20$, and $20 \times 41 = 820$ turns of No. 15 can be put in the same space that previously contained $15 \times 30 = 450$ turns of No. 12. By making the new coil square $(5 \times 0.091) \div 0.066 = 6$ more 41-turn layers, or $6 \times 41 = 246$ turns can be put on. This gives a total of $820 + 246 = 1{,}066$ turns, which leaves

1,390 — 1,066 = 324 turns still required. Inspection reveals that the height of the coil cannot be increased, but that there is plenty of room between poles to allow each coil to be made thicker. Then 324 ÷ 41 = 7 layers and 37 turns, or each coil will require 8 extra layers. The last layer will have only 37 turns; this will increase the total thickness of the coil 2 × 8 × 0.066 = 1.056 in., which in this case was passable, there being considerable space between coils.

Next, considering the armature that has 47 bars and coils, each coil consisting of 2 turns of two No. 7 round wire. If the voltage per bar is not too high, the 47-bar commutator may be used and make all new coils 4 turns of one No. 7, which fulfills the requirement and does not require a change in the mechanical arrangement of the coil. Checking the volts per bar with 47 bars, 250 volts, there will be 47 ÷ 4 = 11.75 bars per circuit or 250 ÷ 11.75 = 21.28 volts, which has been found satisfactory in practice in some cases, although this value is getting up around the danger point for a non-interpole machine. Should it be decided to play safe and reduce the voltage between bars, the alternative would be to have a 93-bar commutator made up and use the old coils, which would give 2 × 47 = 94 single coils of two turns of one No. 7 wire. Since there are two wires per bar, there will have to be one dead coil to satisfy the wave-winding formula. The lead pitch can be (93 — 1) ÷ 2 = 46, or 1 and 47, short pitch.

The volts per bar will then be $250 \div \frac{93}{4} = 10.75$, which is a safe value. The changes made in the field and armature circuits in the above machine brings out the fact that there is more to a voltage change than just changing the size of wire and turns.

Where a new commutator can not be obtained conveniently or new wire to make a new set of coils, on account of the time element, the two groups of turns in each coil could be connected in series so as to make a four-turn coil. Each coil is wound with two turns of two No. 7 wires in parallel, so that each coil has two beginnings and two endings, and by connecting one beginning to an ending to give a continuous circuit, a coil of four turns will be obtained.

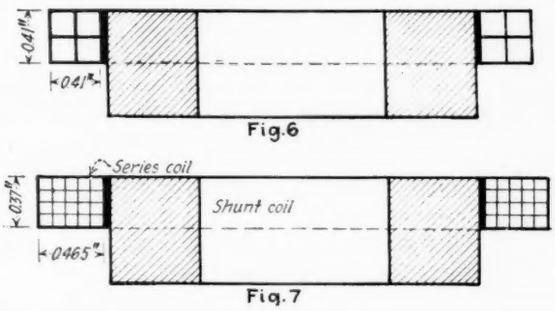


Fig. 6

Fig. 7

FIGS. 6 AND 7—SECTION THROUGH SHUNT AND SERIES FIELD COILS

If the series coil Fig. 6 is correct for 110 volts, the coil Fig. 7 has the right number of turns for 550 volts.

In another problem it is desired to change a 5-hp. 110-volt compound-wound interpole 850-r.p.m. 4-pole 38.2 ampere motor for 550 volts. The 110-volt data show the shunt-field coils to have 960 turns per coil of one No. 21 d.-c.c. wire; the series coils, 4 turns of No. 5 square d.-c.c. wire. There are only two interpole

TABLE I—PROPERTIES OF ROUND COPPER WIRE

Size, B. & S. Gage	Diameter in Inches								Area, Cir. Mils	Area, Sq. In.
	Bare	S.-C. C.*	D.-C. C.	T.-C. C.	Enamel	S.-C.C. and Enamel	D.-C.C. and Enamel	S.-S.C. and Enamel		
0000	0.460	0.469	0.478	0.487	.....	.....	.....	.....	211,600	0.16619
000	0.410	0.418	0.428	0.437	.....	.....	.....	.....	167,800	0.13179
00	0.365	0.374	0.383	0.392	.....	.....	.....	.....	133,100	0.10454
0	0.325	0.334	0.343	0.352	.....	.....	.....	.....	105,500	0.08286
1	0.289	0.298	0.307	0.316	.....	.....	.....	.....	83,690	0.06573
2	0.258	0.267	0.276	0.285	.....	.....	.....	.....	66,370	0.05213
3	0.229	0.238	0.247	0.256	.....	.....	.....	.....	52,630	0.04134
4	0.204	0.213	0.222	0.231	.....	.....	.....	.....	41,740	0.03278
5	0.182	0.191	0.200	0.209	.....	.....	.....	.....	33,100	0.02600
6	0.162	0.170	0.178	0.186	.....	.....	.....	.....	26,250	0.02062
7	0.144	0.152	0.160	0.168	.....	.....	.....	.....	20,820	0.01635
8	0.129	0.136	0.143	0.150	.....	.....	.....	.....	16,510	0.01297
9	0.114	0.120	0.126	0.132	.....	.....	.....	.....	13,090	0.01028
10	0.102	0.107	0.112	0.117	.....	.....	.....	.....	10,380	0.00815
11	0.0907	0.096	0.101	0.106	.....	.....	.....	.....	8,234	0.00647
12	0.0808	0.086	0.091	0.096	0.0832	0.0883	0.925	.....	6,530	0.00513
13	0.0720	0.077	0.081	0.086	0.0743	0.0793	0.827	.....	5,178	0.00407
14	0.0641	0.069	0.073	0.078	0.0663	0.0713	0.747	.....	4,107	0.00323
15	0.0571	0.062	0.066	0.071	0.0593	0.0643	0.0683	0.0607	3,257	0.00256
16	0.0508	0.056	0.060	0.065	0.0529	0.0578	0.0620	0.0543	2,583	0.00203
17	0.0453	0.050	0.054	0.059	0.0472	0.0523	0.0563	0.0486	2,048	0.00161
18	0.0403	0.045	0.049	0.054	0.0422	0.0473	0.0513	0.0437	1,624	0.00128
19	0.0359	0.041	0.045	0.050	0.0377	0.0428	0.0468	0.0393	1,288	0.00101
20	0.0320	0.037	0.041	0.046	0.0338	0.0388	0.0428	0.0352	1,022	0.00080
21	0.0285	0.033	0.038	0.043	0.0302	0.0353	0.0393	0.0316	810.1	0.00064
22	0.0254	0.031	0.035	0.039	0.0271	0.0323	0.0360	0.0285	624.4	0.00050
23	0.0226	0.029	0.032	0.037	0.0242	0.0290	0.0333	0.0256	509.5	0.00040
24	0.0201	0.025	0.029	0.034	0.0216	0.0265	0.0305	0.0232	404.0	0.00032
25	0.0179	0.023	0.027	0.032	0.0193	0.0245	0.0283	0.0209	320.4	0.00025
26	0.0159	0.020	0.025	0.030	0.0172	0.0223	0.0263	0.0189	254.1	0.00020
27	0.0142	0.018	0.023	0.028	0.0155	0.0203	0.0245	0.0173	201.5	0.00016
28	0.0126	0.016	0.022	0.027	0.0139	0.0188	0.0225	0.0155	159.8	0.00013
29	0.0113	0.014	0.020	0.025	0.0125	0.0175	0.0210	0.0143	126.7	0.00010
30	0.0100	0.013	0.019	0.024	0.0111	0.0160	0.0199	0.0130	100.5	0.000079
31	0.0089	0.011	0.018	0.023	0.0100	0.0150	0.0187	0.0120	79.70	0.000063
32	0.0080	0.010	0.017	0.022	0.0090	0.0140	0.0177	0.0110	63.21	0.000050
33	0.0071	0.009	0.016	0.021	0.0080	0.0133	0.0167	0.0098	50.13	0.000039
34	0.0063	0.008	0.0153	0.0203	0.0072	0.0123	0.0159	0.0090	39.75	0.000031
35	0.0056	0.007	0.0146	0.0196	0.0064	0.0115	0.0152	0.0083	31.52	0.000025
36	0.0050	0.006	0.0140	0.0190	0.0058	0.0110	0.0145	.....	25.00	0.000020
37	0.0045	0.005	0.0135	0.0184	0.0052	.....	0.0139	.....	19.83	0.000016
38	0.0040	0.005	0.0130	0.0178	.....	.....	0.0134	.....	15.72	0.000012

* S.-C.C., single-cotton covered; D.-C.C., double-cotton covered; T.-C.C., tripple-cotton covered; S.-S.C., single-silk covered.

coils, and each coil has 60 turns of one No. 5 square d.-c.c. wire. The armature is wave wound, 2-circuit, 33 slots, 99 bars and 33 coils. Each coil is wound with 3 turns of 6 No. 13 d.-c.c. wires in parallel, which gives 12 leads per coil, 6 tops and 6 bottoms, 4 wires per bar. Three coils are wound in one so that the conductors are arranged 6 deep by 3 wide, or 36 wires per slot. The pitch of the coil is 1 and 9, and the leads are pitched 1 and 51, long pitch.

The field and armature coils will all have to be rewound with 550 ÷ 110 = 5 times the turns, having 110 ÷ 550 = ⅕ the original area. The shunt-coil turns equal 960 × 5 = 4,800 per coil. A No. 21 round wire has an area of 810 circ.mils, Table I; then the new size equals 810 ÷ 5 = 162 circ.mils. According to the wire table the nearest size is No. 28, which has a cross-sectional area of 159.8, and this is satisfactory. Therefore the 550-volt shunt coils will each have 4,800 turns of No. 28 d.-c.c. wire. The coils can be mush wound, since to wind them in layers with this small wire would be too expensive and unnecessary.

The new series coil will have 4 × 5 = 20 turns. A No. 5 square wire has a cross-sectional area of

TABLE II—PROPERTIES OF SQUARE COPPER WIRE

Size, B. & S. Gage	Diameter in Inches — Bare	D.-C.C.*	T.-C.C.	Area, Circ.Mils	Area, Sq.In.
0000	0.460	0.483	0.497	265,152	0.20825
000	0.410	0.433	0.442	209,345	0.16442
00	0.365	0.388	0.397	165,037	0.12972
0	0.325	0.348	0.357	130,124	0.10220
1	0.289	0.312	0.321	102,292	0.08034
2	0.258	0.281	0.290	80,203	0.06300
3	0.229	0.252	0.261	60,732	0.04927
4	0.204	0.227	0.236	50,737	0.03985
5	0.182	0.205	0.214	39,725	0.03120
6	0.162	0.183	0.191	32,340	0.02540
7	0.144	0.163	0.171	25,439	0.01998
8	0.129	0.146	0.153	19,951	0.01567
9	0.114	0.129	0.135	16,221	0.01274
10	0.102	0.115	0.120	12,783	0.01004
11	0.0907	0.103	0.108	10,033	0.00788
12	0.0808	0.093	0.098	7,868	0.00618
13	0.720	0.083	0.088	6,162	0.00484

* D-C.C., double-cotton covered; T.-C.C., triple-cotton covered.

39,725 circ.mils; then the size of wire for 550 volts equals 39,725 ÷ 5 = 7,945 circ.mils. Table II shows that the nearest size is No. 12 square, which has an area of 7,868 circ.mils and is the size that will be used. The ampere rating for 550 volts will be 38.2 ÷ 5 = 7.64 amperes, and this value allows 7,868 ÷ 7.64 = 1,028 circ.mils per ampere. Since 900 to 1,000 circ.mils per ampere is a good value, the 550-volt coils will be satisfactory when wound with a No. 12 square wire. Next, checking the formation of the series coil which is wound over the shunt coil, two wide by two deep as in Fig. 6, the diameter of No. 5 square d.-c.c. wire is 0.205 in. and that of No. 12 square d.-c.c. is 0.093 in. Then two No. 5 wires will be 2 × 0.205 = 0.410 in. wide. The number of No. 12 wires that will fit in this space is 0.410 ÷ 0.093 = 4. Then with 20 turns per coil there will have to be five layers of four turns per layer. The five layers will be 5 × 0.093 = 0.465 in. thick, or the new coil will be 0.465 — 0.410 = 0.055 in. thicker, which is hardly noticeable. Therefore the 550-volt series coils will have 20 turns of one No. 12 square d.-c.c. wire arranged as in Fig. 7. This coil could also be wound 4 layers of 5 turns per layer, but the first arrangement is the best, as it leaves a greater surface of the shunt coil exposed, which improves the heat radiating capacity of this coil.

The interpole turns for 550 volts will be 60 × 5 = 300 per coil, and the size of wire will be the same as for the series coils, or No. 12 square d.-c.c. The old coils were wound in six layers of ten turns per layer. Then the turns per layer with No. 12 will be 10 × 0.205 ÷ 0.093 = 22, and the number of layers will be 300 ÷ 22 = 13 of 22 turns and one layer of 14 turns, or a total of 14 layers. The old coils were 6 × 0.205 = 1.230 in. thick, and the new coil will be 14 × 0.093 = 1.302 in., which is 1.302 — 1.230 = 0.072 in. thicker per side, but as the top layer will not extend to the bottom of the coil, there is no danger of the series and interpole coils interfering.

When figuring the armature winding, first check the voltage between bars to determine whether a new commutator will be required or if the old one will do. The commutator has 99 bars; then for a two-circuit winding the voltage per bar equals 550 ÷ (99 ÷ 4) or 550 ÷ 24.75 = 22.22 volts, which is a safe value for a machine with interpoles. Therefore the 99-bar commutator can be used. The turns per coil for 550 volts equals 110-volt turns times 5, or 3 × 5 = 15. In the 110-volt coils there were two No. 13 wires in parallel. One No. 13 has a cross-sectional area of 5,178 circ.mils; then the area of the 550-volt wire will be 2 × 5,178 ÷ 5 = 2,071.2 circ.mils. The nearest standard size to this is No. 17, which has an area of 2,048 circ.mils and will be used. The armature coils can also be wound mush, as there will be 99 coils of 15 turns each, or 99 × 15 ÷ 2 = 742.5 turns per circuit, and the volts per turn equal 550 ÷ 742.5 = 0.74. This is a low value, so a mush-wound coil would be safe to use.

When figuring the series and interpole coils, in many cases considerable room can be saved by selecting a square wire one size smaller than the required round wire. The smaller square wire will have nearly the same area as one size larger round wire. For example, suppose after calculations it is found that a No. 7 round wire is required in the series field and that owing to the increased turns and smaller wire which will decrease the space factor, the new coils are larger than the old. If room is limited the coil size can be decreased by using a square wire. According to Table I the area of a No. 7 round wire is 20,820 circ.mils, and in Table II a No. 8 square wire is found to have 19,951 circ.mils, or 20,820 — 19,951 = 869 circ.mils less, or about 4 per cent less, which is safe to use. Comparing the diameter of No. 7 round d.-c.c. wire with a No. 8 square, it is found that the latter is 0.014 in. smaller, therefore the width and height of the coil is decreased 0.014 in. for every turn. This also applies to armature coils and when making a change in the winding where the insulation to ground must be increased, substituting a square for a round wire will increase the space available for insulation.

Moisture in transformer oil may be measured by means of an electric-spark-gap test. In many substations it is not possible to obtain an expensive apparatus of this kind when required. Boiling the oil in a tin bucket or similar vessel will reveal almost as low a percentage of moisture as the spark-gap method. In order to make this test, first take perfectly pure oil and boil it and observe that practically no noise is made. Then stir this oil with a piece of stick or paper that is slightly damp, and notice the crackling that takes place. By using a thoroughly dry piece of wood dampened with a very small portion of a drop of water, it will be readily seen how small a quantity of moisture may be detected by this method.

Boiler-Room Features of Northeast Station

Special High-Pressure Piping—Hydraulic Operation of Long Valves—Combination Valve Bypass and Drain—Station Heat Balance

IN THE previous article, in the issue of July 3, the plan view, Fig. 2, gave some indication of the layout of the high-pressure steam piping in Northeast Station, Kansas City. Leads from either side of the boiler join through a Y-fitting into a single line, which again combines with a similar lead from the adjacent boiler by means of a second Y-fitting before the steam from the two boilers enters the main header. This scheme of

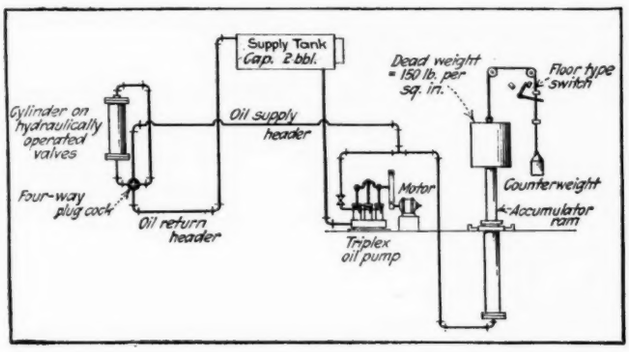


FIG. 1—DIAGRAM OF HYDRAULIC SYSTEM OPERATING LARGER VALVES

joining the two outlets from each boiler before they enter the header permits the use of a single steam-flow meter per boiler and uses one gate valve instead of two. The other two boilers are connected up in the same way and the combination supplies steam to the turbine of the unit or, if need be, steam to the initial section of the plant. Long sweeping bends take care of expansion and contraction. An auxiliary 6-in. header supplies steam to the feed pumps and other steam-using equipment around the plant.

All the high-pressure piping is extra-heavy, with cast-steel fittings on the larger sizes and Sargol joints throughout. In the new section of the station no screwed fittings have been used. All joints are flanged even down to diameters of $\frac{3}{4}$ in. The construction is expensive, but is considered good practice for steam temperatures in the vicinity of 650 to 665 deg. F.

Hydraulic Operation of Valves

A feature of the piping system is the hydraulic operation of all steam-header and sectionalizing valves and the large valves in the condenser circulating-water piping. Fig. 1 is a diagrammatic sketch of the system used. All the valves on the circulating-water lines in the new condenser well, and also those on the steam headers in the boiler room, are provided with hydraulic cylinders. The operating fluid used is oil supplied at a pressure of 150 lb. by a triplex pump driven by a 220-volt direct-current motor. The pump is started and stopped and the pressure on the system maintained uniform by means of a weighted accumulator. The opening and closing of the motor circuit is accomplished by a simple type of float switch connected with the accumulator weight. The oil returns from the valve being operated, pass into a supply tank which in turn is connected with the suction of the triplex pump.

The accumulator is of such a size that its complete displacement will operate any of the 12- to 16-in. valves in the steam header. The second operation of one of these valves or the single operation of one of the large 36- to 54-in. circulating-water valves causes the accumulator to descend to such a point that the float switch closes and the triplex pump is started. This pump continues to operate until the demand for oil is over and the counterweight, attached by a cable to the accumulator, opens the circuit by virtue of the fact that the main accumulator weight has reached its top position.

This system insures a uniform operating pressure and utilizes a fluid that does not corrode the pipes and valve cylinders or make the four-way plug cocks stick. The usual source of supply for operating hydraulic valves is the boiler-feed headers. As these lines usually run near steam headers, they are subject to derangement from any rupture of the latter. The oil operating system is not influenced by any such station trouble nor is it affected by any electrical shutdown, as the motor

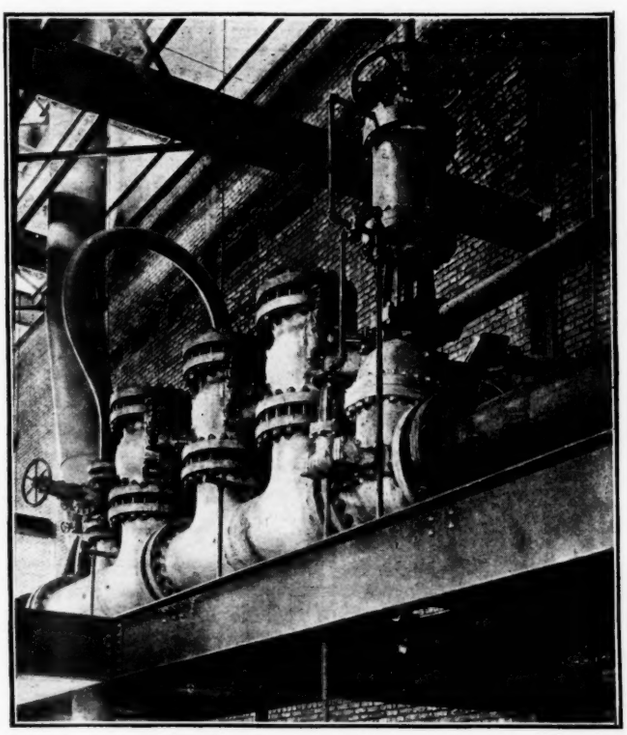


FIG. 2—GROUP OF HEADER VALVES HYDRAULICALLY OPERATED AND EQUIPPED WITH COMBINATION BYPASS AND DRAIN VALVES

driving the triplex oil pump changes over automatically to the storage battery when any failure in its normal supply of current occurs.

Another innovation in the piping system is the combination bypass and bleeder connection designed for gate valves in the vertical position. The new construction, which was designed by Mr. Jowett, is shown in Fig. 3. An extra flange has been cast on the body of

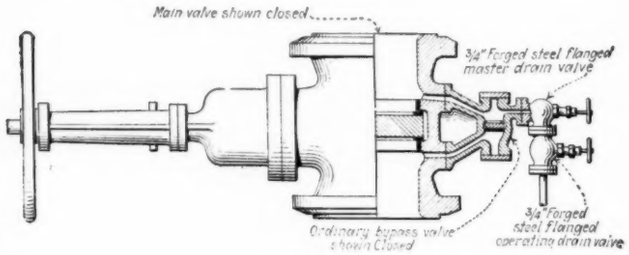

Main valve shown closed
¾" Forged steel flanged master drain valve
¾" Forged steel flanged operating drain valve
Ordinary bypass valve shown Closed

FIG. 3—TYPICAL COMBINATION BYPASS AND DRAIN CONNECTIONS FOR GATE VALVES IN VERTICAL POSITION

the usual bypass valve and the drain valve attached. In the illustration both the main valve and the bypass valve are shown closed, but the drain continues to function.

Feed-Water System and Station Heat Balance

In the feed-water system every effort has been made to prevent the absorption of oxygen to minimize corrosion in the steel-tube economizers. In the heat-balance diagram, Fig. 4, covering both the initial and the present units, the path of the feed water through a closed system from hotwell to boiler may be traced. From the condenser hotwell the feed water is first forced through an extraction heater, enough steam being extracted under hand control from the main turbine at a pressure of 16 lb. absolute to raise the temperature of the water to 175 to 185 deg. F. The feed next passes into a large boiler-feed storage tank serving the entire plant.

Makeup water amounting to about 3½ per cent, three parts of which are clean drips and drains and four parts raw water, is collected in the main makeup storage tank in the basement. This tank receives all the returns from the steam system and raw water to the amount required is admitted under float control. Above the feed-water heater is a reserve makeup tank. Motor-driven pumps transfer the supply from one tank to the other under the control of a float in the upper tank. From here the makeup water passes as required into the makeup heater, which is of the new deaërating type, the deaërating feature consisting of a reboiler or scrubber, or in other words, a manifold with a number of laterals with small holes drilled in them, located in the water-storage section of the heater. As soon as the water has absorbed sufficient heat to build up the desired temperature of about 212 to 215 deg., and a slight back pressure exists, the steam enters the manifold and the laterals, passes out through the holes in a number of small jets and, in rising to the surface of the water, carries with it the small air bubbles present in the water. Gleaners or a small surface condenser remove the air from the heater and return any condensed vapor.

The source of heat for the makeup water is saturated steam passed through the house turbine to keep it cool while it is floating on the line ready to take up the auxiliary load in case of an electrical disturbance on the system. Sufficient steam is obtained in this way to raise the temperature of the makeup water to 212 deg. F. The purpose of boiling the makeup water is to remove any dissolved oxygen present in the raw water or picked up by the drips and drains in the open makeup storage tank. The remainder of the boiler feed, being

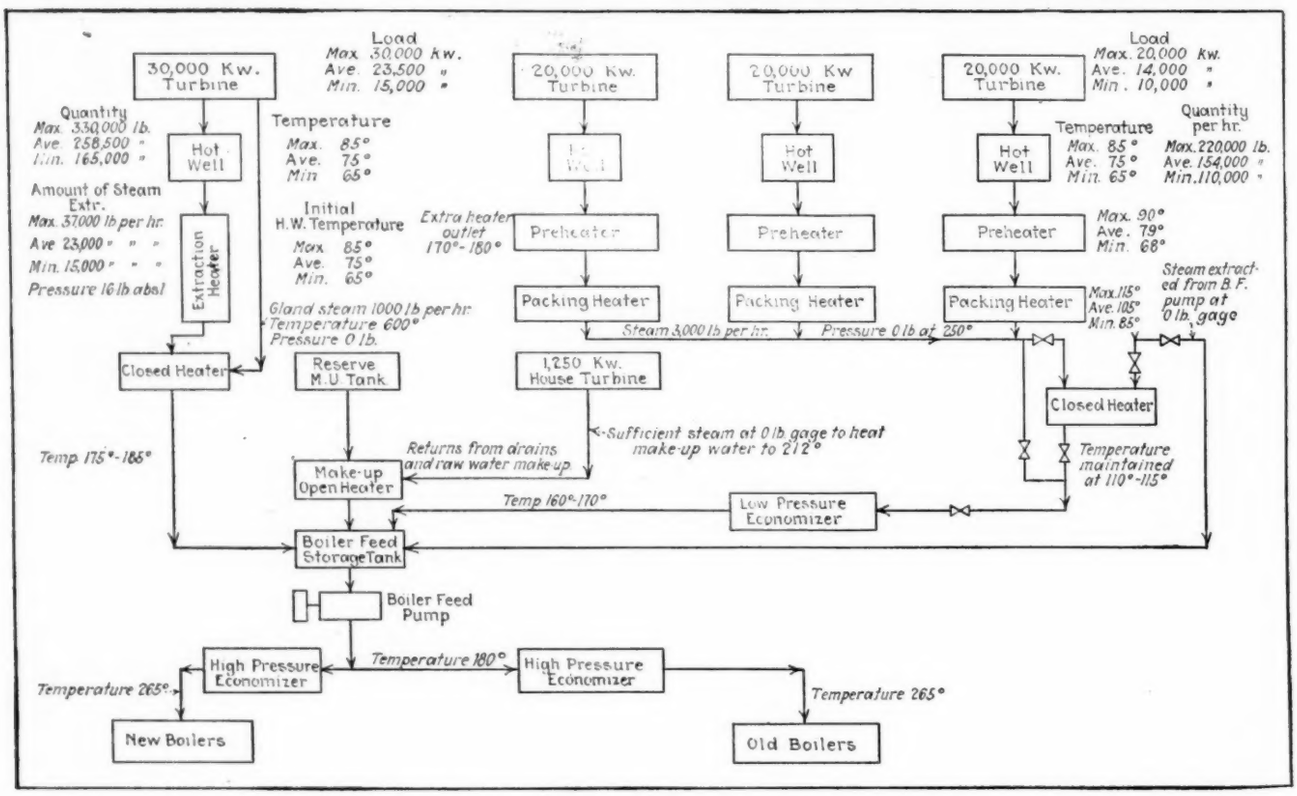

30,000 Kw. Turbine
Load Max. 30,000 kw. Ave. 23,500 " Min. 15,000 "
20,000 Kw. Turbine
20,000 Kw Turbine
20,000 Kw. Turbine
Load Max. 20,000 kw. Ave. 14,000 " Min. 10,000 "
Quantity Max. 330,000 lb. Ave. 258,500 " Min. 165,000 "
Temperature Max. 85° Ave. 75° Min 65°
Hot Well
Temperature Max. 85° Ave. 75° Min. 65°
Quantity per hr. Max. 220,000 lb. Ave. 154,000 " Min. 110,000 "
Amount of Steam Extr. Max. 37000 lb per hr. Ave 23,000 " " " Min. 15,000 " " " Pressure 16 lb abs
Extraction Heater
Initial H.W. Temperature Max. 85° Ave. 75° Min. 65°
Extra heater outlet 170°-180°
Preheater
Max. 90° Ave. 79° Min. 68°
Packing Heater
Steam extracted from B.F. pump at 0 lb. gage
Max. 115° Ave. 105° Min. 85°
Gland steam 1000 lb per hr. Temperature 600° Pressure 0 lb.
Steam 3,000 lb per hr.
Pressure 0 lb at 250°
Closed Heater
Reserve M.U Tank
1,250 Kw. House Turbine
Sufficient steam at 0 lb gage to heat make-up water to 212°
Temperature maintained at 110°-115°
Temp 175°-185°
Returns from drains and raw water make-up
Make-up Open Heater
Temp 160°-170°
Low Pressure Economizer
Boiler Feed Storage Tank
Boiler Feed Pump
Temperature 180°
High Pressure Economizer
Temperature 265°
New Boilers
Old Boilers

FIG. 4—HEAT-BALANCE DIAGRAM OF STATION

condensate, is practically free from oxygen and does not need to be heated above the temperature indicated. At an average temperature of about 180 deg. F. feed water with the required amount of makeup is taken from the main storage tank by the boiler-feed pumps and passed through the high-pressure economizers in either section of the plant to the boilers at about 265 deg. F.

In the diagram comparison may be made with the feed-water system adopted for the initial section of the plant. Here there are preheaters located in the condensers, gland heaters and a closed heater taking steam from the boiler-feed pumps before delivery of the feed water to the low-pressure elements of the economizers. The final temperatures obtained compare closely with those of the new unit, so that the two systems work into each other nicely, being brought together in the main boiler-feed storage tank.

With five turbine-driven feed pumps already installed, there was need for only one more pump to meet the added requirements of the new unit. This pump is motor driven, so that it may be operated when the exhaust-steam requirements are low. Each of the steam-driven boiler-feed pumps is under governor control, and at the boilers there is individual feed-water regulation. To meet emergencies there are main and auxiliary feed lines. Venturi meters measure the feed to each boiler and the condensate from each turbine. A V-notch records the quantity of makeup water used.

[In the description of the Northeast Power Station of the Kansas City Power & Light Co., appearing in the issue of July 3, it was erroneously stated that the closed extraction and gland heaters were manufactured by the Alberger Pump & Condenser Co. These heaters were supplied by the Alberger Heater Co., of Buffalo, New York.—Editor.]

Hints on Transformer Operation

A fire within the tank of an oil-insulated transformer can be extinguished by directing the streams from one or two "soda" fire extinguishers into pipes entering the tank above the oil level, or by turning carbon tetrachloride into a perforated pipe placed within the tank above the oil. Especially in the West, transformer compartments are provided with removable metal bulkheads as a protection against flooding in the event of a tank explosion, but such an occurrence is extremely rare.

Thermometers that can be easily read from the floor should be used on all transformers of importance, and if limit loads must be carried, some form of electrical temperature indicator that will always show the temperature within the winding is essential. Unless proper allowance for the time lag is made when thermometers only are employed, their indications will be misleading, for the temperature of the windings may be 15 deg. greater than that shown by the thermometer.

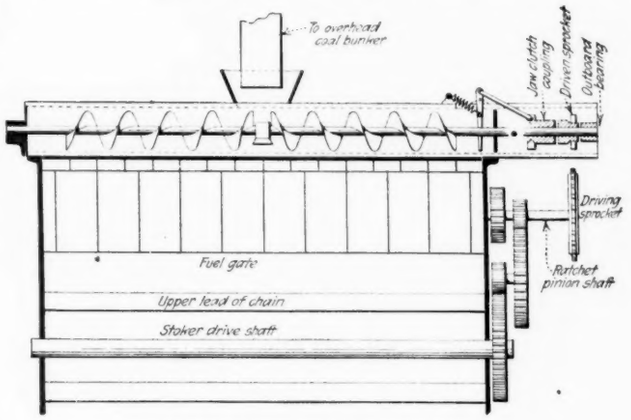
All external metal parts of a transformer should be kept well painted, and the station number or designation should appear conspicuously on the tank. Indoor transformers are usually painted a black or dark-green color, while gray paint is considered most suitable for outdoor installations

All parts of a transformer, especially the high-voltage bushings, should be kept clean by wiping as often as conditions require. This is important, for bushings have been known to fail because of accumulations of dirt. Oil gages should be kept clean and in working order, and should be plainly marked to indicate the limits within which the oil level must be maintained. The oil level in the tank should be noted daily, and entered, together with the oil temperature, in a space that should be provided on the station log sheet. It is important that the oil in oil-filled bushings be kept at the normal level.

Especially when riveted tanks are used, oil leaks may cause considerable annoyance, and even if the value of the insulating oil lost by leakage is negligible, the requirement of cleanliness calls for the prompt stoppage of all leaks. If calking or welding will not stop leaks, piping should be installed to drain all leakage into a tank or receiver, from which it may be drawn and filtered for future use.

Universal Coal Spreader

To eliminate the difficulties encountered from a fuel bed of uneven density when feeding coal to a chain grate through single or divided spouts and the losses introduced by neglect of a swinging spout, J. W. Himmelsbach, of the Universal Coal Spreader Co., 511 Monadnock Bldg., Chicago, has developed the automatic coal spreader shown in the illustration.



AUTOMATIC COAL SPREADER

This labor-saving device, consisting of right and left screw conveyors, receiving the coal at the center and distributing it both ways to the hopper of the stoker through V-shaped openings in the bottom of the conveyor trough, increasing in width from the center out, automatically keeps the hopper filled and the coal distributed evenly as to coarse and fine. The spreader may be driven by an independent motor, but preferably through a sprocket and chain from the stoker drive shaft, as the speed of the conveyor will vary then with the travel of the grate.

The spreader is designed to supply the maximum fuel requirements of the stoker it is to serve. To guard against feeding an excess amount of coal and jamming during periods of light load, an automatic stop in the form of a plate at one end of the conveyor trough is provided. Pressure of the coal from the conveyor against this plate throws out a clutch if the drive is mechanical, or with a motor drive opens a switch. When the pressure is released, a spring attachment provides for re-engaging the spreader mechanism. Patents have been applied for on this device and its application to multiple-retort underfeed stokers is being developed.

An Automatic Oil-Engine Light Plant

By COLIN K. LEE

FOLLOWING the burning of a small steam-driven light plant in a Missouri town of 1,400 inhabitants, the owners decided to install oil engines. The steam plant had been losing money for a number of years, and it was hoped by the use of oil engines not only greatly to reduce the fuel cost, but also to run most of the time without attendance. This was of course impossible with steam.

The plant peak load never exceeded 70 hp., and this for only two or three hours in the evening, while the load during the rest of the day varied from 20 to 50 hp. These load conditions apparently called for two engines, one of 50 and one of 25 hp. However, the company's funds were so low that the investment required for this equipment was out of the question. As a solution two 25-hp. semi-Diesel engines and a 20-hp. Fordson tractor engine were purchased. Oddly, the two 25-hp. units cost much less than a single 50-hp. engine, this being due to the fact that the smaller engines were horizontal and of a light construction, while the 50-hp. engine of the same make was of the vertical type and was built for heavy duty. Since the peak load was of short duration, the Fordson engine seemed logical, for the cost of the kerosene fuel would not greatly exceed the cost of the gas oil used in the semi-Diesel. In addition

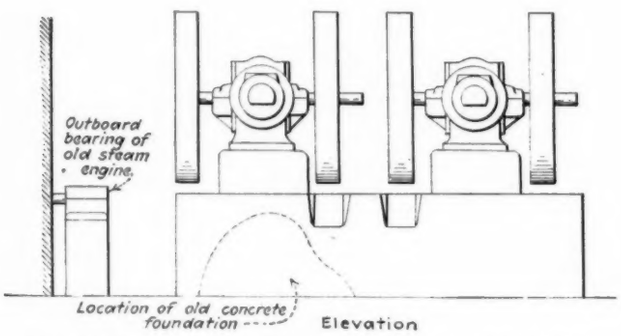


FIG. 1—LOCATION OF THE TWO 25-HP. SEMI-DIESELS

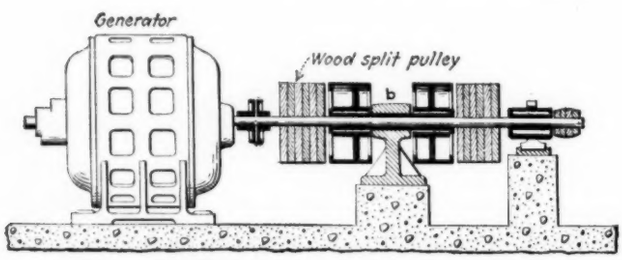


FIG. 2—TIGHT AND LOOSE DRIVEN PULLEYS ON GENERATOR

the first cost was less than one-half that of a semi-Diesel engine.

The same element of first cost dictated the purchase of a single generator to be driven by the two semi-Diesels rather than two small generators. The frames of such small generators usually are identical with those of larger machines and this increases the cost per kilowatt capacity and lowers the generator's efficiency.

The two engines were installed side by side, as outlined in Fig. 1. Since one engine during the light-load period would handle the generator, tight and loose pulleys were put on a shaft extension which was coupled to the generator shaft as shown in Fig. 2. The tight pulleys were wood, while the loose pulleys were cast-

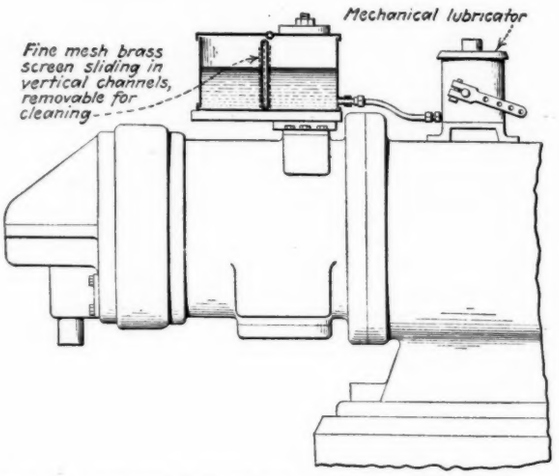


FIG. 3—ARRANGEMENT OF LUBRICATING-OIL TANK

iron and were placed on a pipe that slipped over the shaft and was held by a pedestal bearing *b*. In this way the idle pulleys did not rest on the rotating shaft and the entire structure was very rigid. The Fordson tractor was belted to a 20-kva. generator, the two generators being synchronized by means of lamps.

The schedule of operation was to have the engineer, who also attended to the outside work, give personal attention to the plant during the peak load at night. At this time the two semi-Diesels drove the 50-kva. generator in parallel with the 20-kva. generator driven by the Fordson engine. After the peak load was over, the Fordson engine was shut down and the two semi-Diesels carried the load the remainder of the night and all day. In the winter it was necessary for the engineer to start the Fordson and run it from 6 a.m. to daylight.

Safeguards Necessary to Allow Engines to Operate Without Attendance

A study of the situation indicated that if the semi-Diesel engines were to operate without attendance, several safeguards must be provided. In the first place a supply of lubricating oil for the mechanical lubricator was essential. This was provided for by the addition of oil tanks placed over the cylinder of each engine and connected to the mechanical lubricator, as shown in Fig. 3. The second and equally important point was a continuous supply of cooling water. The water was supplied by a triplex pump belted to the dynamo shaft. From the engines the water went to the top of a cooling tower made of lath, with eight decks placed one foot apart and set above a large sheet-metal "stock tank," as indicated in Fig. 4. At the top of the cooling tower was placed a long wooden lever, one end carrying a bucket with holes punched in the bottom. Normally, the bucket was full to overflowing and was depressed,

but if the water flow stopped, the bucket emptied itself through the holes in the bottom. From the other end of the lever led a long wire over pulleys and terminating in a heavy weight hung beside the engine cylinder. These engines get their fuel supply from a cup that is kept filled by a fuel pump. In the suction line of this fuel pump was inserted a valve which the dropping of the weight opened, admitting air and breaking the pump suction. Thus the failure of cooling water caused the emptying of the water bucket, the counterweight then fell, and the fuel pump ceased to supply fuel.

The arrangement as outlined proved to be quite successful save in one particular. It required the presence of an attendant to stop one of the semi-Diesels when the load fell off sharply and again to start it up when the load came on, because at very light load the engines would not divide the load equally and one engine would take it all. The other would then begin missing, grow cold, and the live engine would pull the dead one as part of its load.

Over-Running Clutch Pulley Installed

To take care of this, an over-running clutch pulley, Fig. 5, was made to take the place of one of the split wood pulleys on the dynamo extension shaft. In case the load went off, the engine driving this pulley was able to run a little behind the other, whose governor was tightened to cause it to run at a low-load speed somewhat above the low-load speed of the second engine. Its friction load would keep the idling engine hot enough to fire, and when the load came on, it picked up its share without requiring an attendant to shut it down or start it.

To make the engine divide the load fairly at full load, the adjustment nuts on the fuel pumps were set to cause the two belts to run in parallel curves.

Operation as outlined permitted one man to do all the work of every sort connected with the plant. Such labor was available in this town for from $80 to $110 a month. Constant attendance would have required at least three men and a total payroll of over $240 a month. As the plant's gross income was about $550 a month, this plan produced a saving of about 24 per cent of the gross income. The last few months of steam operation had cost between $400 and $500 a month for fuel, while the labor ran to nearly $300, not including the clerical work. Fuel and lubricant with the oil engines averaged $45 and $30 a month respectively.

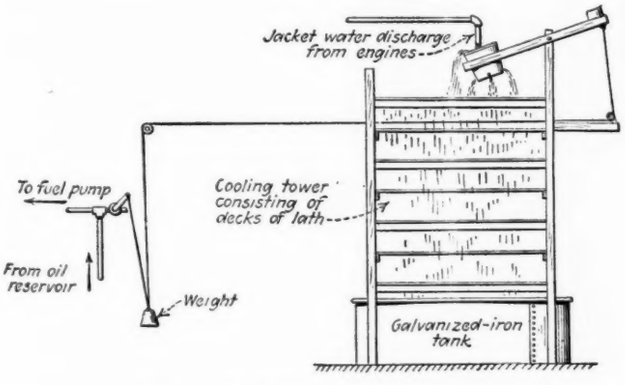


FIG. 4—COOLING-TOWER DESIGN

Various operating troubles were encountered, but no more than were to be expected in a plant where the engineer was inexperienced with this form of power. It was clearly demonstrated that such a plant can be run unattended for about 18 of every 24 hours. It is also felt that a power unit based on a tractor or similar engine is a useful and reliable source of power for operation a few hours only each day.

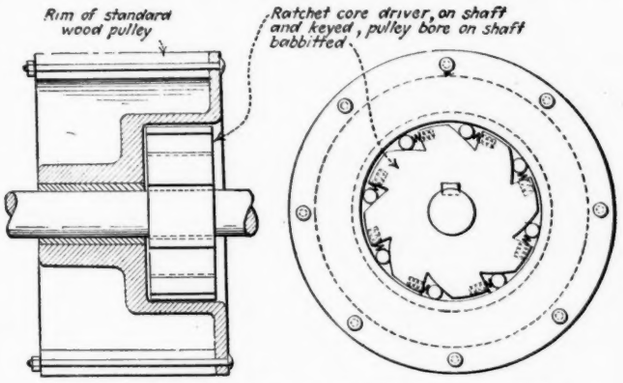


FIG. 5—OVER-RUNNING GENERATOR PULLEY

Determining Quantity of Condensing Water Required

By E. C. Miller

The chart shown herewith for determining the amount of water required for surface condensers is based on the following formula:

$$\textit{Gal. of condensing water per min.} = \frac{\textit{lb. of steam per hr.} \times \textit{latent heat of the steam}}{(t_2 - t_1) \times 8\frac{1}{3} \times 60\ (\textit{minutes})}$$

in which t_2 is the temperature of water leaving condenser, t_1 is the temperature of water entering condenser, and $8\frac{1}{3}$ is the weight of one gallon of water.

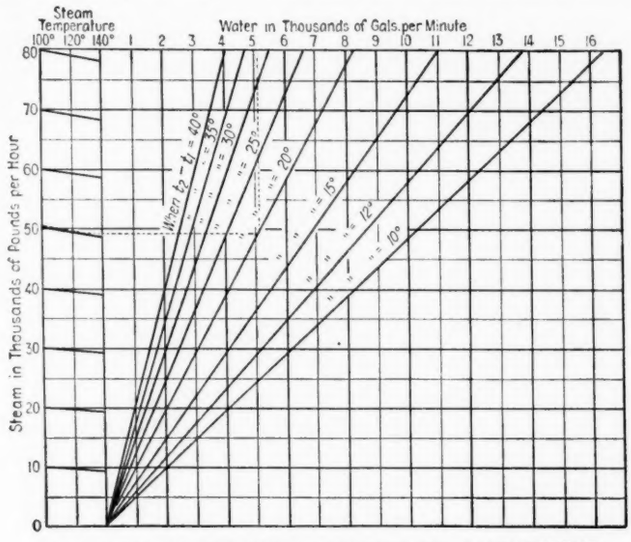

Steam Temperature
100° 120° 140°
Water in Thousands of Gals. per Minute
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Steam in Thousands of Pounds per Hour
0 10 20 30 40 50 60 70 80
When $t_2 - t_1$ = 40°
35°
30°
25°
20°
15°
12°
10°

CHART TO DETERMINE AMOUNT OF CONDENSING WATER REQUIRED

The example shown on the chart is for 50,000 lb. of steam an hour at 26.1 in. vacuum. The temperature of the steam at this vacuum is 124 deg., and the temperature difference in the water, leaving and entering condenser, is 20 deg. or $\frac{50{,}000 \times 1{,}022.2}{(90 - 70) \times 500} = 5{,}111$ gal. per min.

Performance of Large Chain-Grate Stoker at Calumet Station

Features of construction and results obtained on stoker 24 ft. wide by 18 ft. 3 in. long. Burning 35 lb. of Illinois coal per hour per square foot of grate maintained boiler operation at 240 per cent of rating. Over-all efficiency averaged 81 per cent. Power for auxiliaries was less than ¾ of 1 per cent, and the ashpit loss was held to the unusually low figure of 1 per cent.

IN THE description of the Calumet Station of the Commonwealth Edison Company, Chicago, appearing in *Power* about a year ago, mention was made of the big B. & W. forced-draft chain-grate stoker being installed under one boiler at that time. Beginning late in the fall and continuing all winter, operating tests were made on this stoker with gratifying results. Some of the figures obtained at the average rate at which the unit is being operated, 240 per cent of rating, are available and in conjunction with a review of furnace and stoker proportions may be of interest.

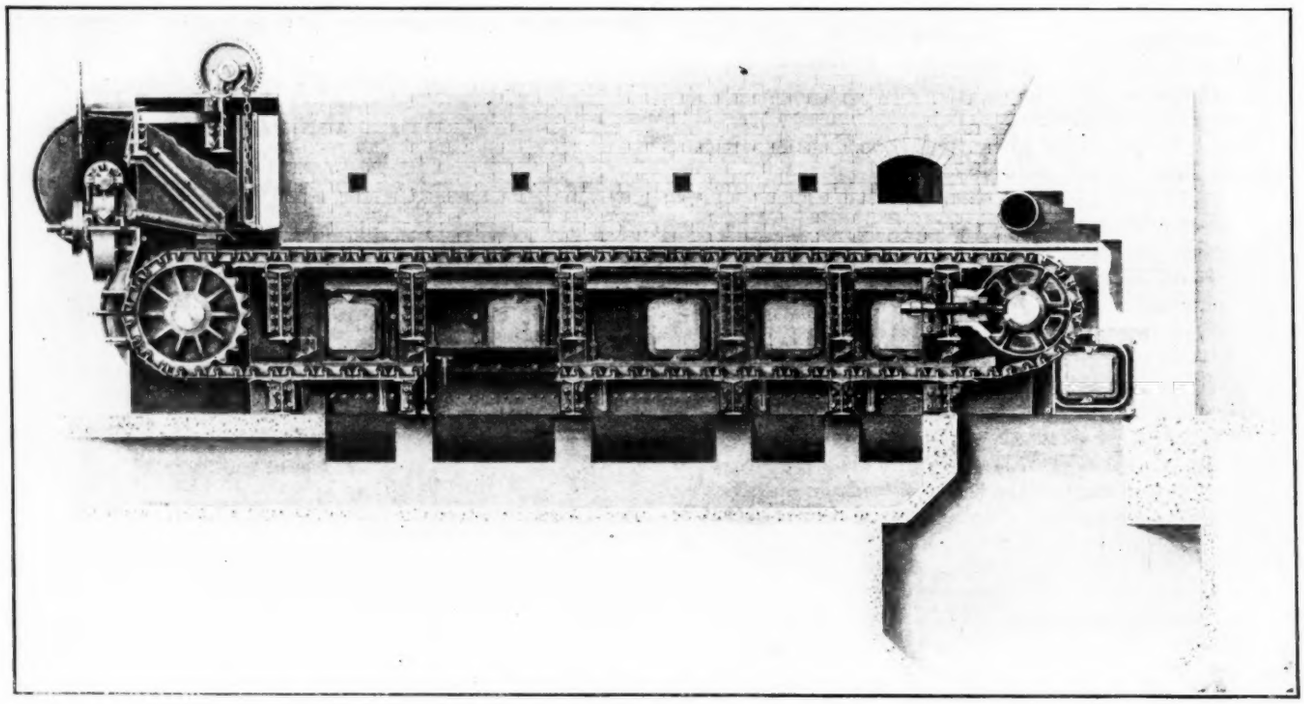


FIG. 1—SECTION OF THE LARGE STOKER, SHOWING CONSTRUCTION

The stoker is 24 ft. wide and 18 ft. 3 in. long, giving a grate area of 438 sq.ft., but in test calculations it has been customary to take the effective grate area as 410 sq.ft., which, to a steam-making surface of 15,089 sq.ft. in the boiler, bears a ratio of 1 to 36.8.

Over this entire area the grate surface is continuous. The driving shafts are coupled at the center and a driving motor at either side is provided, the two motors being under common control. They are direct-current machines with a range in speed from 400 to 1,600 r.p.m., two sets of worm gearings being provided, so that the speed of travel of the chain can be varied between 2 and 12 in. per minute.

The grate has several rows of forged-steel driving links that pass over sprocket wheels on the shaft at each end of the stoker. The driving shaft is at the front and carries at each end a steel wormwheel through which the power is supplied. With this arrangement the top run of grate is maintained in compression, so that the siftings through an air space of 7 per cent are insignificant, not exceeding, according to report, 50 lb. an hour out of a total quantity of 14,350 lb. of coal burned in the same period. These siftings rarely exceed 25 per cent carbon, owing to the fact that most of it drops through the rear end, where the chain changes from compression to tension, and at this point the burning out of the fuel is almost completed.

Reference to the illustrations will show the general arrangement. At either side is a side-wall blast box supplying air to the five compartments into which the stoker is divided. There is an individual damper and access door at either end of each compartment. The dampers for each compartment are operated independently of those of the other compartments. A multivane fan, with a capacity to deliver 40,000 to 60,000 cu.ft of air a minute, depending upon the pressure, driven by a 50-hp. induction motor, is provided to supply each blast box. There is interconnection, however, between the ducts so that one fan may be used to supply the air to both sides of the stoker, and has done so during normal operation at 240 per cent of rating.

The top run of the chain slides on 1-in. square bars carried by six 20-in. I-beams connecting the opposite side-wall boxes. To the bottom flange of each I-beam is attached a U-shaped seal of sheet steel hinged to allow the steel to fit snugly on the chain without interfering with its motion. This construction is shown in the sectional view of the stoker, Fig. 1. Below these large cross members, six 9-in. I-beams between the side-wall boxes carry a ⅜-in. steel plate stiffened by angles, which forms the stoker bottom. The lower run of the chain slides along this plate, so that all siftings through the grate from the fuel bed are carried forward by the bottom run of the chain and discharged automatically at the front of the stoker.

To prevent clinker adherence, water boxes 7¼ in. square are built into the side walls of the furnace at the grate line and connected into the boiler circulation. The rear of the stoker is set 4½ in. higher than the front to give sufficient pitch to the side boxes to insure circulation and prevent the formation of steam pockets. At the rear a 10-in. water-back at an average height of 10 in. above the grate, acts as an air seal and also protects the bare links going over the rear drum against heat reflected from the overhanging bridge wall. This particular water-back has the distinction of being 29 ft. long.

An Example of Smokeless Operation

With the plant situated in a locality notorious for its smoke, it was desired to set an example of practically smokeless operation. This was secured by large furnace volume and the provision of ten 2x4-in. holes through the vertical leg of the ignition arch. The air drawn in at these points gives the oxygen needed by the excess of hydrocarbons distilled at the front of the stoker, so that the gases are burned more completely and the production of smoke obviated. Incidentally, this air tends to prevent excessive temperatures in the fire arch.

It will be evident that the main arch has been set high. At the front it is 51 in. above the grate and at the rear this dimension increases to 57 in., giving a rise of 6 in. in the 8 ft. of arch length.

Underneath the arch the volume of the primary combustion chamber is 725 cu.ft. The secondary combustion chamber, including the remainder of the space up to the tubes, has an effective volume of 4,131 cu.ft., this having been reduced from 5,264 cu.ft. to eliminate the corners and waste spaces not functioning as available combustion volume. The total effective volume is thus 4,856 cu.ft., which reduces to 11.8 cu.ft. per square foot of effective grate area, or to 0.34 cu.ft. per pound of coal burned per hour at the 35-lb. combustion rate maintained when operating at 240 per cent of rating. More intensive combustion is of course possible. Per square foot per hour a rate of 53 lb. has been attained, and 55 lb. is considered the maximum possible for this installation.

Over-all Efficiency of 81 per Cent Maintained

In the tests that have been conducted at 240 per cent of rating, corresponding to an evaporation of 110,000 lb. of water an hour, efficiencies of 75 per cent for the boiler and 81 per cent over boiler and economizer have been maintained. With Central Illinois coal running about 14.5 per cent moisture and 13.5 per cent ash as fired and averaging 10,200 B.t.u., an evaporation of 6.85 lb. of water per pound of coal has been secured. The coal was crushed to a size so that all of it would pass through a 1½-in. round screen.

Over the fire a draft of 0.2 in. was maintained under all conditions with the pressure in the different zones changing to meet the varying requirements. At the rating given, the furnace temperature ranged in the vicinity of 2,700 deg. F. and the ignition temperature approximated 2,200 deg. F. With superheating surface of 4,052 sq.ft. located above the first pass, a superheat of 220 deg. F. was obtained and an economizer surface of 9,670 sq.ft. reduced by 180 deg. an uptake temperature of 540 deg. F. In other words, the flue gases escaped to atmosphere at a temperature of 320 deg. F. The rise in the water temperature in the economizer approximated 100 deg. F.

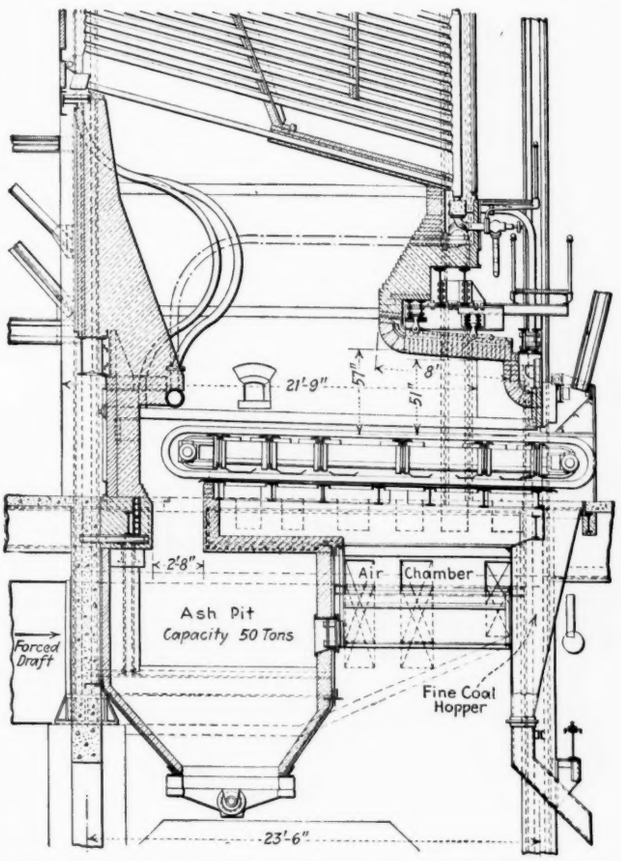


FIG. 2—SECTIONAL ELEVATION THROUGH FURNACE AND ASHPIT

At the boiler uptake the CO_2 averaged 13 per cent and at the suction of the induced-draft fan it was 12.5. An ashpit loss of 1 per cent is the lowest on record for the company, and another feature worthy of mention is the requirement of less than ¾ of 1 per cent for auxiliary power.

The loss of head in hydraulic valves and other fittings occurs partly within the valve or fitting itself and partly in the pipe line downstream, since the normal flow has been disturbed by the eddies that result from such losses.

The total coal output in 1921 was 507 million tons, while in 1920 it was 558 million tons. On account of the depression in 1921, less energy was used in manufacturing in nearly every state of the United States than the previous year.

Starting and Loading an Electric-Ship-Propulsion Turbo-Alternator

By LIEUTENANT COMMANDER A. M. CHARLTON, U.S.N.

AN ARTICLE in the March 20 issue described a method of placing turbo-generators in service as representing standard practice of a large central station. The operation of starting up the turbo-alternators for an electric-drive battleship and putting the load on them is considerably different from that which obtains in land service.

Aboard ship the turbo-alternators have but one connected load—that of the induction motors attached to the propellers. The lighting and auxiliary power is supplied by direct-current turbo-generators which also act as exciters for the main drive turbo-alternators.

The routine of getting under way developed on the U.S.S. "Tennessee" is typical for the electric-drive battleships now in commission in the Navy.

The propelling plant of the "Tennessee," as shown in Fig. 1, consists of two turbo-alternators each of a nominal rating of 13,250 kva. They are two-pole three phase 34.6 cycles 3,270 volts at 83.4 per cent power factor. At 2,195 r.p.m. they have a maximum rating of 14,850 kva. Each alternator is driven by a Westinghouse semi-double-flow turbine designed for 16,000 b.hp. at 2,075 r.p.m. with 250 lb. steam, 50 deg. superheat and 28.5 in. vacuum. The main generators are connected through a switching station called the control room, to the four propelling induction motors. The rotor of each motor is rigidly coupled to its propeller shaft.

TWO 13,250-kva. turbines drive four propelling motors. Eight oil-fired boilers supply 250 lb. steam at 50 deg. superheat. The ship can be got under way from shutdown conditions of boilers and turbines in two hours by the regular starting procedure; this time may be greatly reduced under emergency conditions. After starting up, the supplies of fuel, feed water, lubrication, etc., are regulated from the control room.

Each main turbine has its own condenser, circulating pump, forced-lubrication system and governor-control system, and exciters. Each unit is in its own watertight compartment, with the turbo-alternators, exciters and switchboard on one flat and the auxiliaries in a pumproom below. As the exciter also furnishes current for 240-volt auxiliaries, a booster motor-generator is installed for each alternator, so that the field current of the latter may be varied for the different voltages required by the generators. The alternators are never put in parallel, but each is connected to two motors when both alternators are in use. Arrangements are made, of course, so that one alternator may drive all four motors up to the limit of its power.

When the ship is at anchor, she will have in operation one boiler out of eight, one 300-kw. direct-current turbo-generator out of six for the lighting and power, one boiler-feed pump and one fuel-oil pump. When word comes to get under way with full power, the watch is sent below into both engine rooms and into all fire-rooms. If sufficient notice has been given, the regular routine of operation is carried through as outlined in the table and here explained in detail.

The boilers are run down to steaming level before the watch goes below. (All dead boilers are kept full of water.) In the preliminary period the bilge, fuel- and lubricating-oil strainers are examined and cleaned. The oil wells on the bearings of the fuel-oil and main feed pumps are cleaned and the oil renewed. Lubricating oil is run down from the storage tanks to the drain tanks. The throttle valve and the hand-operated nozzle valves on the main turbines are tried to make sure they are not frozen on their seats. If no notice of getting under way has been given, the aforementioned preliminaries are attended to after the watch gets below.

The fuel-oil, main-feed and blower steam valves to each boiler are opened in the engine room. Each boiler with its forced-draft blower is in a separate air- and water-tight compartment, and cutout valves are provided in the engine rooms as well as in each fireroom.

Two hours is taken as the necessary time between lighting off boilers and moving the ship, although this time can be cut in half in an emergency.

The boilers are lighted off and the steam pressure brought up slowly with one or two of the six burners on a boiler lighted. One boiler is brought along more rapidly and cut in as soon as possible in order to provide steam for warming up.

The communication system is manned and tried out. On a Naval vessel, where the power plant is divided into fourteen separate compartments with no communicating doors below the water line, good communications are vital to proper operation. On the "Tennessee" there are two engine rooms, one control room, three motor and eight boiler rooms.

The primary means of communication is by telephone. A talker in each compartment wears a head-set telephone, and all talkers are in parallel on the line all the time. The telephone system is supplemented by voice tubes and visual signals.

As soon as two boilers are on the line, another 300-kw. turbo-generator is started to assist in furnishing power for the main drive auxiliaries, most of which are motor-driven.

The injection and overboard valves which control the circulating water for the main condensers are opened and the circulating pumps started up slowly. The valves on the condenser heads are cracked, and any air that may have accumulated is released.

Another feed pump and another fuel-oil pump are started. The boilers may feed through two separate systems, one supplied by pumps in the forward engine room and one by pumps in the after engine rooms. The ship is usually operated with the starboard boilers obtaining their feed from forward and the port boilers

from aft. Failure of one system thus affects but half of the boilers simultaneously. The fuel system is on a loop with the pumps feeding into it on opposite sides.

An electric driven forced lubrication pump is started on each main turbine. These pumps also supply oil pressure for the governor control. The after pump in addition supplies oil for the main motor bearings and for the thrust blocks on the propeller shafts. The stand-by pumps for this system are steam-turbine-driven arranged so that upon failure of bearing pressure a quick-opening valve operates and the pumps immediately make up the pressure.

The bypass to the steam chest from the main steam line is cracked and the turbine and steam chest drains opened. The vacuum breaker on the main turbine is opened and the air pump run slowly, keeping two to four inches vacuum on the condenser. When pressure on the steam chest has reached line pressure, the main stop is opened and the bypass closed.

The governor on the main turbine is of the flyball centrifugal type. As it is necessary to govern at various speeds, depending on that desired for the propellers, means must be provided for changing the governor setting. Furthermore, as the control of the generator field, the switching for the propeller motors and the governor control are in a compartment removed from the main turbines, there must be a distant control of the governor setting. This is accomplished by connecting a hydraulic piston with the flyball shaft of the governor and replacing the effect of centrifugal force on the flyballs with that of pressure from the piston. This pressure is changed from the control station by means of a speed-wheel which varies the opening of a valve and admits more or less pressure to the hydraulic piston. A hydraulic pressure of 5 lb. per sq.m. causes the turbine to idle at about 500 r.p.m., while 60 lb. per sq.in. will cause the governor to maintain its full speed of 2,100 r.p.m. Thus for every position of the speed wheel there is a definite governed speed on the turbine.

Before rolling the main turbine this system is tried out and steam is turned on the shaft gland system with just enough pressure behind it to blow steam out along the shaft. The vacuum breaker is closed and the vacuum brought up to 12 or 14 inches.

The amount of steam allowed in the turbine is controlled by hand-operated nozzles. Various combinations of these will give the most efficient operation at different speeds. For full power Nos. 1, 2 and 3 are opened.

To start the turbine, the throttle is opened quickly until the first stage pressure builds up to about 50 lb., at which the turbine will begin to turn over. As soon as the turbine starts, the throttle is closed and gland rubs are listened for. The turbine is given steam at intervals until it comes up to idling speed.

The turbine drains are closed and the throttle valve is opened. The dampers on the main generator stator housing are opened. The generators are self-ventilated, a fan on the rotor taking air from the engine room and discharging it through the stator to a trunk leading to the deck. Control of the turbine speed is now taken over by the control room and the speed gradually raised to try out the control. At 1,000 r.p.m. the gland steam is automatically cut off and sealing water of 7 lb. pressure turned into the glands.

The emergency hand trip on the throttle valve is

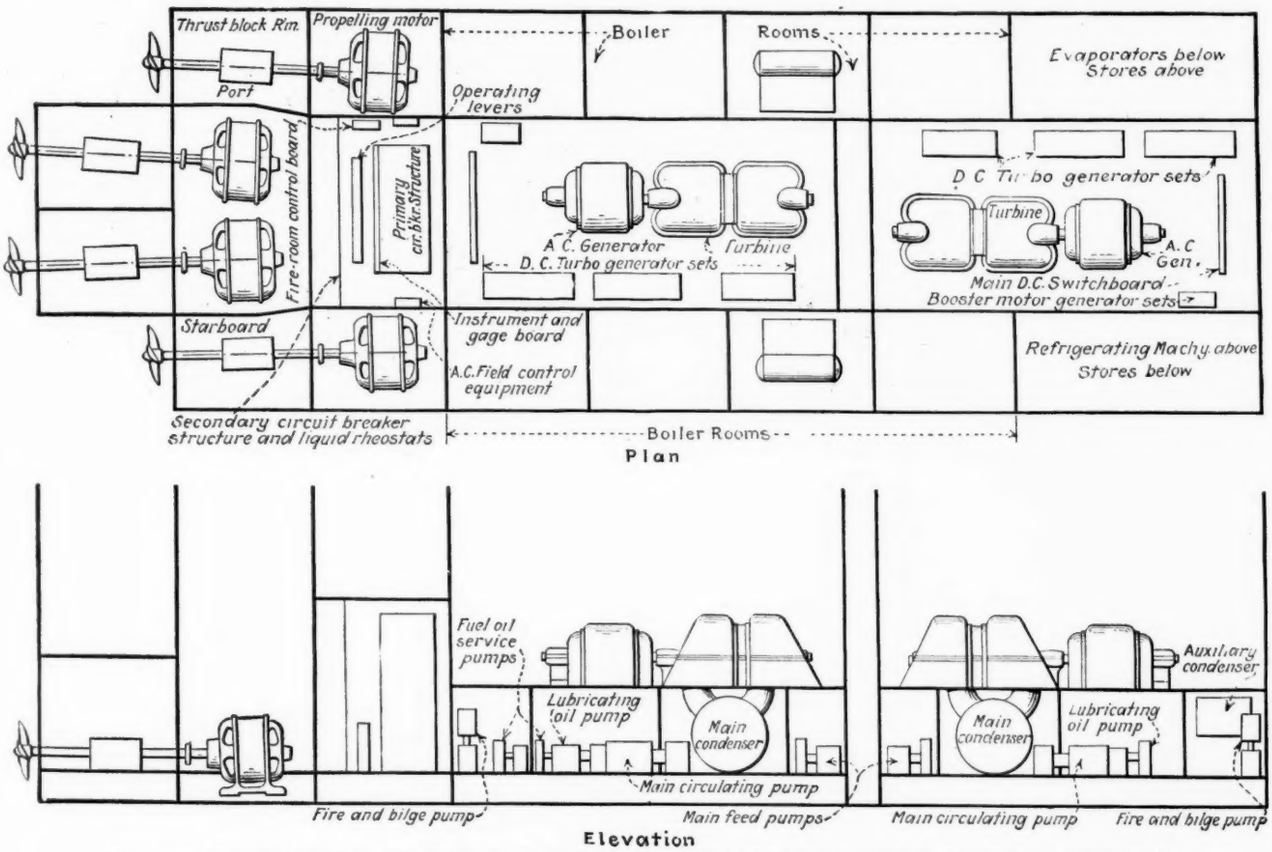


FIG. 1—TWO 13,250-KVA. REACTION-TYPE TURBO-GENERATORS DRIVE FOUR PROPELLER MOTORS

tried from the control room, the throttle reset and the turbine brought back to idling speed. After the control room takes over the operation and the gear is found to operate correctly, the vacuum is raised to 26 inches.

The lubricating-oil cooler is cut in and water supply to the shaft alleys bearings and thrust blocks turned on.

In each engine room a 300-kw. non-condensing turbo-generator is started with its exhaust directed into the main turbine. The main drive electric auxiliaries in each engine room are loaded on this machine. It is not usually paralleled with any other generator, and the auxiliaries are connected inside its circuit-breaker.

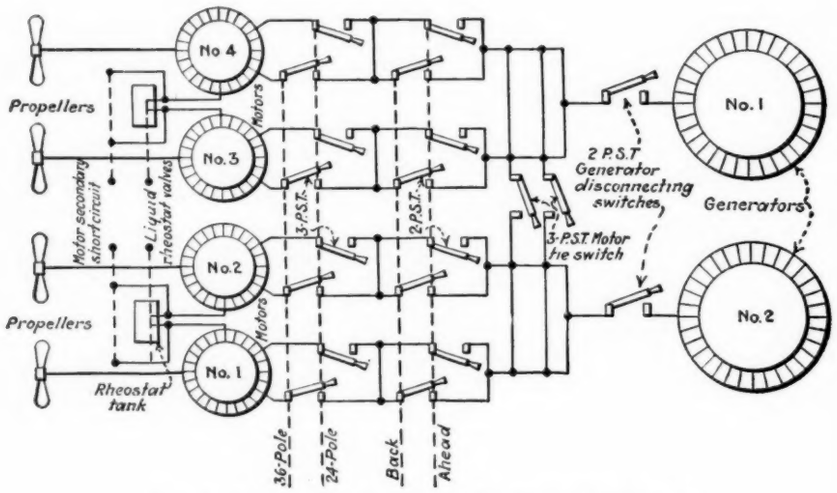


FIG. 2—MAIN DRIVING TURBINE UNITS OPERATE INDEPENDENTLY OF EACH OTHER

Before turning over the motors the main field booster motor-generator is started. The field of the booster generator is varied from the control room and the voltage generated can be added to or subtracted from the normal exciter voltage of 240 supplied by the 300-kw. machine. As the propeller speed bears a constant ratio to the generator speed, the latter must be changed for various speeds. This results in a variable-frequency, variable-voltage alternator, and so a variable field is necessary.

The motors of the "Tennessee" are wound for 24 poles and 36 poles, giving a speed reduction of 12 to 1 and 18 to 1. The 12 to 1 reduction is used at full power. The rotors are of the wound type, and the windings connect through slip rings to water rheostats which furnish resistance for starting and backing, as in Fig. 2. The rheostats have water pumped through them constantly, and the amount of resistance put in series with the rotor depends on the water level, which can be raised or lowered by a lever-operated valve. The motors always start with full resistance in circuit.

With the turbine at idling speed the following procedure is observed to start the motors:

Close main generator, ahead, and 24-pole switches. Close the field switch. This makes the field circuit and adds all the booster voltage, so that over-excitation is applied to the main field. Close the rheostat valves. This allows the water to rise in the rheostats, gradually cutting out resistance in the rotor circuit and allowing the motors to be pulled into step. When all is cut out, a motor secondary switch is closed which short-circuits the slip rings on rotor. The speed wheel, which, by changing governor oil pressure, raises the speed of the turbine, is gradually moved to the full-speed position. The motor ventilating fans are started as soon as the motors are turning over. Each motor has two forced-draft fans mounted on top of the stator housing. Air is drawn down from the deck through a trunk, through the motors and discharged to the deck through another trunk.

As soon as the ship is under way, the normal vacuum apparatus, consisting of motor-driven condensate pump and air ejectors, is started on the main turbines and the steam-driven air pump is secured. A vacuum of 28 to 29½ in. is now maintained. As the vessel speeds up, more burners are lighted under the boilers, feed and fuel pumps started on the feed and fuel lines as needed, and the circulating pump speeded up to take care of the added exhaust steam in the condensers.

All operations are directed and most of them controlled by the operator in the control room. He has a gage board in front, with electric meters and steam gages mounted so that a glance will show the status of the plant. Colored lights tell him when circuits are energized. Electric engine, order, and revolution telegraphs connect with the bridge. With telegraphs he directs the number of burners to be used on each boiler and the pressure to be carried on the fuel pumps and so adjusts the steam pressure. Electric indicators give the speed of the alternators and of the propellers. Nothing can better illustrate the possible control of this plant than the fact that the propellers can be reversed from 30,000 hp. ahead to the same amount astern within twelve seconds.

GENERAL OUTLINE OF OPERATIONS IN STARTING UP

This sequence is not always strictly adhered to, depending on how long in advance the notice of starting is given and other conditions.

1. Watch sent below to engine and fire room stations.
2. Boilers standing full of water are drained to steaming level.
3. Fuel and lubricating systems inspected and cleaned.
4. Turbine steam valves tried.
5. Fuel oil cleared to boilers and steam to main feed pump and blowers.
6. One or two burners of each boiler lighted.
7. One boiler brought to full pressure somewhat ahead of the others.
8. Communication system manned and tried out.
9. An additional auxiliary turbo-generator is started up when two boilers are on the line.
10. Condenser circulation started.
11. Additional steam-driven pumps for fuel and feed water placed in operation.
12. Turbine lubrication pumps, motor-driven, are started.
13. Turbine steam chest drained, warmed and brought to full steam pressure.
14. Condenser air pump started up to give a low vacuum.
15. Auxiliary oil-pressure speed-regulation system tried out.
16. Auxiliary steam turned on sealing glands.
17. Vacuum breaker closed, vacuum brought up to 12 or 14 in.
18. Turbines started by quickly bringing inlet pressure to 50 lb.
19. Throttle now closed and gland rubs listened for.
20. Turbines brought to speed by giving steam at intervals.
21. Remaining boilers cut in about ¾ hour before getting under way.
22. Turbine drains closed and throttle opened wide.
23. Generator air-cooling system placed in operation.
24. Turbine control now taken over by the control room.
25. Control room tries emergency-valve hand trip and resets emergency valve. Vacuum raised to 26 in.
26. Lubricating-oil cooler cut in and propeller-shaft lubrication turned on.
27. Auxiliary non-condensing turbines are connected so as to exhaust into the main turbine.
28. Main booster-field motor-generator started.
29. Electric motors are switched on to generators and started up, together with motor forced-draft fans.
30. When the ship is under way, regular motor-driven vacuum equipment replaces the steam-driven outfit. Vacuum is brought up to 28 or 28½ in.
31. Additional burners, fuel and feed-water pumps are placed in service as the ship speeds up.

Effect of Superheat on Boiler Performance

By R. A. HOLME*

IN THE generation of steam in a boiler without a superheater, an efficiency of 72½ per cent may be realized when burning 14,000 B.t.u. coal at 20 lb. per sq.ft. of grate area under forced draft, with a boiler pressure of 200 lb. per sq.in. and feed water supplied at 212 deg. F. Under these conditions 10 lb. of water

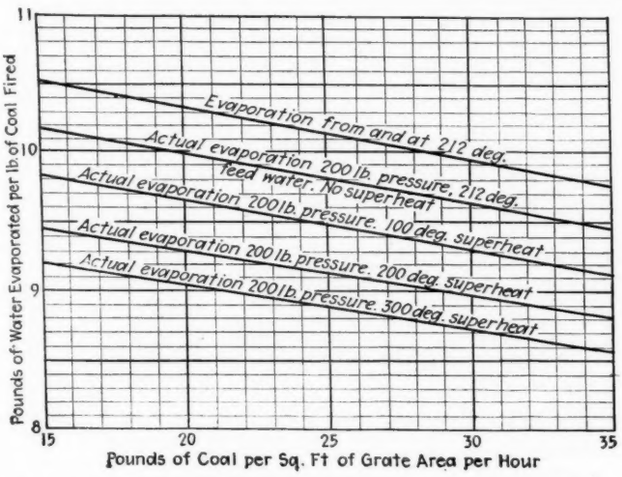

Evaporation from and at 212 deg.
Actual evaporation 200 lb. pressure, 212 deg. feed water. No superheat
Actual evaporation 200 lb. pressure. 100 deg. superheat
Actual evaporation 200 lb. pressure. 200 deg. superheat
Actual evaporation 200 lb. pressure. 300 deg. superheat
Pounds of Water Evaporated per lb of Coal Fired
Pounds of Coal per Sq. Ft of Grate Area per Hour
11
10
9
8
15
20
25
30
35

FIG. 1—COMPARATIVE EVAPORATION UNDER VARIOUS CONDITIONS

will be evaporated per pound of coal burned, and the steam may be considered as being 98 per cent dry.

Fig. 1 shows the evaporation of saturated steam per pound of coal at the various rates of combustion indicated. The normal rate of firing, 20 lb. per sq.in., may be increased to 33 lb. per sq.ft. as a maximum. Taking these two rates of combustion, the evaporation will be 10 lb. and 9.55 lb. respectively. The efficiency of the boiler under the forced conditions would fall to 69½ per cent, or a reduction of 3 per cent below the normal power conditions.

If the boiler be equipped with a superheater, the thermal efficiency will increase, but the evaporative performance will be lower than with saturated steam. The thermal efficiency increases by reason of the higher heat content per pound of steam produced. The evaporative performance will decrease, since a certain amount of the additional heat in the steam entails more coal being burned in the furnaces.

It is, however, not necessary to burn the full amount of coal corresponding to the added heat in the steam, because the superheater utilizes the gases passing by the boiler tubes to better advantage than when no superheater is used. This is accounted for by the fact that the superheater is in direct contact with the gases.

Referring again to Fig. 1, for a given degree of superheat, it will be noted that at the normal rate of firing (20 lb. per sq.ft.) the evaporation per pound of coal is 9.65 lb. for 100 deg. superheat, 9.3 lb. for 200 deg. superheat, and 9.05 lb. for 300 deg. superheat, the corresponding thermal efficiencies being 74¼, 75 and 76¼ per cent, respectively.

Summarizing the foregoing for a rate of combustion of 20 lb. per sq.ft. of grate area with forced draft at the steam conditions mentioned, we have the following:

Superheat, Deg. F.	Evaporation per Lb. of Coal Lb.	Thermal Efficiency, Including Superheater, per Cent
0	10.0	72½
100	9.65	74¼
200	9.30	75
300	9.05	76¼

The gross drop therefore in the evaporative performance as compared with saturated steam is 3½ per cent for 100 deg. superheat; 7 per cent for 200 deg. superheat; 9½ per cent for 300 deg. superheat. Taking into consideration the gain by the evaporative effect of the superheater surface itself, the net fall in evaporative performance is 3 per cent for 100 deg. superheat;

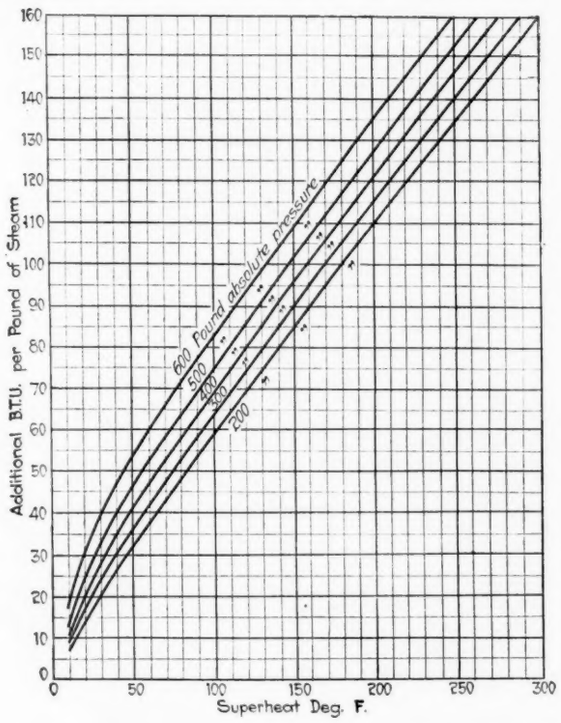


FIG. 2—HEAT REQUIRED FOR SUPERHEATING AT VARIOUS PRESSURES

6½ per cent for 200 deg. superheat; 9 per cent for 300 deg. superheat.

The evaporative performance and boiler efficiency indicated in Fig. 1 refer to forced-draft conditions only. With natural draft the rate of combustion per square foot of grate area per hour will be reduced to from 13 to 16 lb. of coal, and since the air supplied to the furnaces is not heated, the gross thermal efficiency will be 5 per cent lower than in a corresponding boiler operating under forced draft. The steam used by the fan,

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however, may absorb 1½ per cent of the foregoing, so that the net decrease in efficiency is 3½ per cent. The relative economy in coal consumption between forced-draft and natural-draft installations is unaffected by this reduction in thermal efficiency. The gains shown in the previous tabulations for forced-draft boilers are also applicable to installations having boilers operating under natural draft.

When oil is used as a fuel, a higher thermal efficiency is realized, which may be 1 per cent higher than when coal is burned. The better performance is accounted for by the efficient control of both air and fuel and almost complete atomization which results therefrom in modern oil-burning apparatus. The absence of heavy soot deposits and the fact that furnace doors are closed at all times when the boiler is under steam, also contribute directly to high efficiency in burning oil as fuel.

The gas temperature in the furnace will be higher with oil as fuel than with coal. In practice the temperature is about 10 per cent higher. On the other hand, the weight of the products of combustion is less than with coal fuel for the same amount of water evaporated. The net result is that while the stack temperature is lower with oil than with coal as fuel, the degree of superheat is the same.

Fig. 2 shows the additional heat per pound of steam for various degrees of superheat.

For the steam conditions mentioned, this amounts to 59.8 B.t.u. per pound of steam for 100 deg. of superheat, 110.5 B.t.u. per pound of steam for 200 deg. of superheat, and 159.9 B.t.u. per pound of steam for 300 deg. of superheat. The corresponding percentage of added heat contained per pound of steam is as follows: For 100 deg. superheat, 5 per cent; 200 deg. superheat, 9.2 per cent; 300 deg. superheat, 13.3 per cent, measuring from saturation temperature.

The curves of Fig. 1 show that the fall in evaporative performance of the boiler is: For 100 deg. superheat, 3½ per cent; 200 deg. superheat, 7 per cent; 300 deg. superheat, 9½ per cent. Deducting these from the percentage of added heat, the gains in thermal efficiency are as follows: For 100 deg. superheat, 1½ per cent; 200 deg. superheat, 2.2 per cent; 300 deg. superheat, 3.8 per cent. This gain is entirely due to the more effective utilization of the heat in the gases.

Repairing a 23,000 Square-Foot Condenser Shell

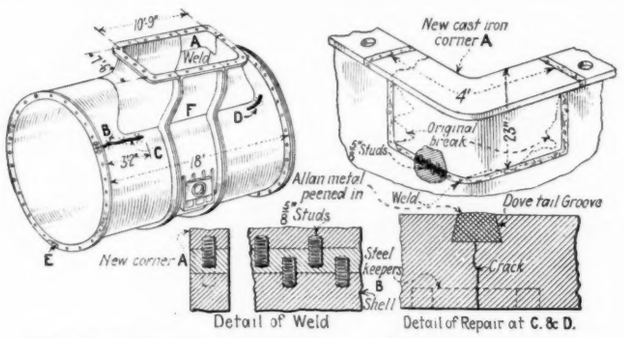
The illustration herewith shows the repairs made to a 23,000-sq.ft. two-pass surface condenser that was damaged when a 12,500-kw. turbine was wrecked on April 2 at the Mill Street station of the Indianapolis Light & Heat Co.[1] The condenser was built by the Worthington Pump and Machinery Corporation in 1912.

Its shell is composed of three castings with bolted vertical joints. The center casting *F* was damaged beyond repair, and the two end castings were cracked, one having a corner of the exhaust inlet connection about four feet long broken away.

The power company decided to install upon the foundation of the wrecked machine a larger (15,000 kw.) unit at that time under construction for them, and to repair the condenser for use with the new turbine. The end sections of the shell were returned to the Worthington Works at Harrison, New Jersey, where they arrived May 3. These sections were repaired as shown in the illustration. The cracked portion was cut away as indicated and a new corner *A* cast and welded to the old section of the shell by the electric welder. Steel studs were screwed alternately into the shell and patch castings as shown.

At the cracks *C* and *D* steel keepers were inserted flush with the inner face of the shell and a dovetail groove was cut along the crack on the outside of the shell. This was filled with Allan metal. A small flange patch was also made at *E*, the piece being attached by screws and then welded.

A new exhaust connecting pipe to match the larger turbine and a new center section *F* of the condenser



SHOWS METHOD OF FITTING NEW CORNER AND OF REPAIRING CRACKS IN SHELL

shell were cast in molds built with dry sand cores to save production time and to enable making the repairs with the least possible delay.

The condenser was re-erected in the shops together with the original water-boxes and new exhaust connecting pipe and given a hydrostatic test. It was reshipped from Harrison to Indianapolis June 9.

An unusual piece of apparatus has just been perfected at the Pittsburgh Experiment Station at the Bureau of Mines in connection with the study being made on spontaneous combustion of coal. This apparatus permits of continual temperature measurements of the coal samples as they are subjected to the conditions that make for spontaneous combustion. Oxygen is passed through the sample so as to permit the development of the heat in a much shorter time than would be required under conditions of actual storage. In this way it will be possible to determine which coals are most likely to take fire. The apparatus was designed and built by A. C. Fieldner, the superintendent of the station, and J. D. Davis, in charge of fuel chemistry.

The United States is one of the largest coal-land owners in the world, according to information collated by the Department of the Interior. The government also owns immense tracts of oil shale, besides important deposits of phosphate, potash and other salts. At the present time the Interior Department supervises between 30,000,000 and 40,000,000 acres of public coal lands through fifteen states, and while mining on private coal lands overshadows mining on public lands, there is every probability that in the future the situation will be reversed. Coal is now being produced from government lands in eight States and there are over one hundred mines. In addition the government has one phosphate lease, one oil-shale lease and four potash leases on public lands.

[1] See *Power*, May 15, 1923.

EDITORIALS

F. R. LOW, EDITOR

Warren Gamaliel Harding

FOLLOWING a week of mourning, culminating in the simple services at Marion, the nation again sets itself to the task of meeting the many problems pressing for solution. It does so, however, not without a feeling that it has suffered an irreparable loss in Harding, the man and the leader, at a time when his council was most needed.

President Harding won the genuine affection of the American people, regardless of political creed, by his intensely human qualities. While possessing the dignity requisite to the office, his simplicity, kindliness and sincerity of purpose won for him friends at every turn. It was these qualities that were ever being brought to bear to conciliate opposing factions at home, and they were beginning to be recognized abroad in a world torn by dissension. At the same time his firmness and insistence on American rights were everywhere recognized and respected.

Undoubtedly, the outstanding accomplishments of his administration were the limitation of naval armaments and the skilful handling of national finances during the period of readjustment.

Moreover, President Harding was both a friend of business and sympathetic with labor. Coming into office at a time when business conditions were disrupted as an aftermath of the war, his policy was to make the government departments agencies for assisting legitimate business whenever the industries indicated a willingness to co-operate.

It has been often said that the breadth of an executive is measured by his willingness to surround himself with big men. If this be true, President Harding, with one or two exceptions, fully met the standard. He conceived of certain things to be accomplished and was not afraid to call upon such men as Hughes, Hoover and Mellon to put them through. He was the first president to accord recognition to the engineering profession by having an engineer in the Cabinet and he inaugurated the custom of having the vice-president meet with the Cabinet, a fortunate procedure in view of subsequent events.

Had he been spared to serve out his term, issues now in the offing would likely have put his leadership to a supreme test. As it is, his memory will go down in history untinctured by the bitterness of political opinion.

Governor Regulation in Large Power Systems

THE governor speed setting of a large prime mover may be adjusted at will by the control-room operator. Irregularities of governor operation may therefore be compensated for to a large extent by hand adjustment. It often follows that the natural tendency is to overlook the subject of governor regulation, provided that the momentary fluctuations in system frequency are not undesirably large. Speed regulation, when systematically investigated and adjusted to the various requirements, may be a decided help in operating a power plant or a large system. If neglected, operation may become difficult or impossible.

A comparatively short range of speed, from no load to full load, tends to maintain a constant line frequency, as well as to promote a speedy recovery from sudden load fluctuations or line disturbances. On the other hand, decreasing regulation also means that the governing device approaches closer to the point of instability, as pointed out at length in previous issues of *Power*. Wear, lost motion, friction or other abnormal condition of the mechanism will then produce greater tendency toward surging than with broad speed variation. Close regulation in general is more desirable from the viewpoint of electrical distribution, and broad regulation is preferable in regard to prime-mover maintenance and operation. In some power plants the problem resolves into obtaining as close a regulation as the mechanical construction of the governing devices will permit, without undue surging.

In an isolated plant frequency is seldom required to be as nearly constant as in a large system. Ordinarily, governors are adjusted only for satisfactory multiple operation. No particular attention is paid to maintaining close regulation. Since governing action is inclined to be smoother and more convenient to maintain mechanically with broad regulation, the latter condition is more likely to exist than the former.

As frequently happens, industrial growth may require the addition of one or two new plants, thus forming a system with the original one. A constant heavy base type of load may be desired for one or both of the newer installations. With close regulation of new machinery, as would obtain from factory adjustment, increasing load variations will be naturally absorbed, which might fit the program admirably. Unfortunately, however, with a decreasing system load, closer regulation will cause the base plant to give up more than its share. This would be equally undesirable. Much regulation of the synchronizing spring tension and consequent load dispatching would probably result.

In order to cut down the load fluctuation of the base load plant, a natural step would be to decrease regulation of the old plant. If this were continued until load fluctuations were taken to a large extent by the old plant, the latter would eventually have a closer regulation than the recent station. Since the new plant represents designed conditions, the older prime movers may easily reach an unstable condition, as a result of shorter speed variation than the recent machines. Cross-current or load surging between units and also the plants themselves would be expected.

Matters should be adjusted so that base stations may tend to take a uniform load, leaving surges principally to the older and less efficient ones and thus minimize hand speed adjustment as much as possible. A reasonable procedure, in view of the fact that frequency must

be maintained as nearly constant as possible, would be to determine the shortest regulation at which governor operation will be mechanically satisfactory. The older station which is most suitable for taking surges, should be given this minimum degree of speed variation and the more economical stations a broader adjustment, if necessary, depending on the operating requirements. Thus the benefits of governor regulation may be realized as far as possible, instead of using hand speed variation to excess in compensating for improper governor adjustment.

Labor Relation in the Anthracite Industry

THE United States Coal Commission has issued, supplementary to its partial Anthracite Report of July first, a report on Labor Relations in the Anthracite Industry.

The frequency with which labor trouble has stopped production of anthracite coal, the disregard of public interest shown on occasion in the attitude of one or the other of the parties to these controversies and the apparent impotence of the public itself have created a situation that the public considers intolerable. In search for a remedy certain citizens are advocating even so drastic a measure as nationalization of the mines, while others are insisting on compulsory arbitration and outlawry of strikes. The demand for some sort of remedial public action is practically universal.

The existing machinery by which labor conditions are adjusted, in so far as they are adjusted, is the outgrowth of the vigorous stand taken, in the interest of the public, by President Roosevelt in the strike of 1902. The Anthracite Coal Commission appointed at that time laid the foundation for machinery that is still functioning.

The Commission deplores the "loose militant utterances" and the "swashbuckling and irresponsible propaganda that emerges from the legal and publicity departments on both sides." "The elimination of irresponsible propaganda and the substitution therefor of authoritative statement of facts and issues, rid of offensive charges and countercharges, would go a long way toward a sane approach to the problem."

The report reviews the organization and procedure with regard to industrial relations from the first serious strike of 1887-88 to the present.

The award of the Anthracite Coal Strike Commission does not recognize the union, but its report includes a strong statement in favor of collective bargaining. There has been a constant tendency toward a realization of this recommendation. The union representatives, who signed the first agreement as individuals, have gradually gotten around to signing as "United Mine Workers of America, Parties of the First Part."

The award stipulates that there shall be no discrimination against a workman on account of his membership or non-membership in the union, but this requirement is constantly and openly evaded by the pressure of unauthoritative strikes by locals on account of the employment of men without the union button, such strikes being not only tolerated but encouraged by union officials, notwithstanding the agreement that work shall not be interrupted until all the prescribed means of settlements of dispute have failed.

"Even while the Commission is deliberating on its recommendations, strikes occur in direct violation of the agreement in attempts to force coal salesmen, electricians, inspectors, etc., into the union."

The impracticability of establishing a scientific wage basis adds to the problem. Conditions vary so that it takes much more time and labor to fill a car in one seam than in another. Rates paid to different miners are therefore not comparable upon either a time or a production basis.

"The whole subject of rates must be approached with a great deal of caution. However incomplete the rate structure in a particular industry may be, it is the result of a growth and experience covering many years. Any proposals that sought a sudden, revolutionary change would be foredoomed to failure. Rather we should seek to build upon the existing rate structure and to modify the process so that the daily operation of rate making will tend toward rather than away from proper adjustment."

We are delighted to see the approval expressed by the Commission of the effect of complete publicity of rates. The problem will be half solved when everybody can see everybody else's figures.

The eight-hour day is the prevailing one in the industry. In some particular services the men work longer, most of them on a twelve-hour basis. The report says:

"Active and continuous complaints come from the men who are working more than eight hours a day and it is certain that as long as the day in excess of eight hours exists, it will continue to be a source of irritation and unrest, when the basic day for the industry is eight hours."

Irregularity of operation and attendance does not appear to be as serious as was supposed.

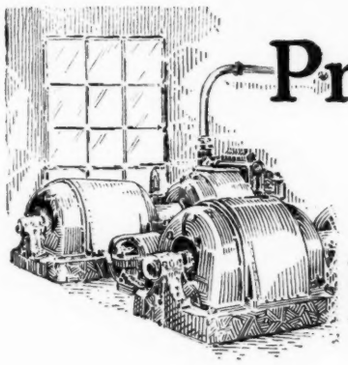
There appears to be a undisputed disposition to evade that clause of the agreements which provides that:

"There shall be no concerted effort on the part of the miners or mine workers of any colliery or collieries, to limit the output of the mines or to detract from the quality of the work performed, unless such limitation of output be in conformity to an agreement between an operator or operators, and an organization representating a majority of said miners in his or their employ."

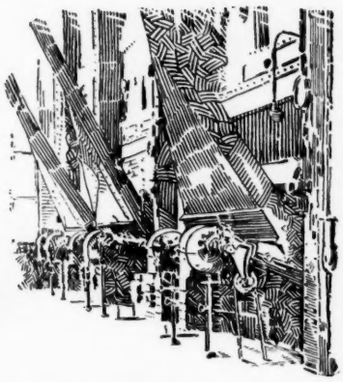
The freedom of the employer to hire and fire has been modified by the practice of the locals of striking when one of their number is discharged rather than letting the case proceed to decision of legal methods without interruption of work. In most cases discharges are made only if the union tacitly consents.

Much dissatisfaction arose from the slowness of the legal processes outlined by the agreement, and one of the leading recommendations of the Commission is that the operators shall have responsible executives appointed to maintain relations with their employees and that the Joint Commission to which appeals must finally come shall be so organized and constructed as to dispose promptly of the cases submitted to it. The umpire who is to decide in case the three representatives of the operators cannot agree with the three representatives of the miners, is required to sit at the hearing of the Joint Commission so as to be already informed of the merits of the case they may come to him for decision.

The *Power* Index for January to June, 1923, inclusive, is now ready and as usual will be mailed to any subscriber upon request.



Practical Ideas *from* Practical Men



"Catalogs and Advertising for the Boys"

The publication of catalogs and advertising is considered by all live manufacturers as the real romance of business. The distribution of the one and the selecting of the field for the other is an ever-present problem. Many, I fear, value their catalogs so highly that unless one is at the moment a prospective buyer, and a good one at that, it is almost impossible to obtain their productions except by stealth—a policy that must lose them many orders. Others get out beautiful catalogs and then neglect to let it be known that they have them and often forget it themselves until they become obsolete. Another serious blunder is that many firms start "too high up" and stay there, forgetting that business in the power field is conducted and controlled by an army of oilers, firemen, attendants and engineers, who must all be considered if any product is to succeed in the true sense of the word. The manufacturer who adopts the reverse of the "too high up" attitude and advertises his products, starting from the bottom and insisting upon his salesman going upon the same lines, can often tell a different story, as the following will show.

A few days ago I visited an agricultural show and, while there, looked up a very old friend, the sales manager of a large firm of plant manufacturers. On going into his tent, I was introduced to a prominent local business man by old Frank as "My son." I knew different, and Frank added, "I have called him nothing else for twenty-three years." Very soon "My son" left, and Frank told me the following story:

"Twenty-three years ago at this very show, a shy little schoolboy came to our stand. For some minutes he stood looking at our catalogs on the table, just as you see them now only not so grand, and presently he said, 'Please, sir, can I have one of these?' 'What would you do with it?' I asked. He replied, 'I like reading about engines.' Then I gave him one. On the table we also had some copies of a trade journal which contained a descriptive article about our engines, and the boy, seeing these, said, 'Please sir, how much do you charge for one of these?' 'How much have you got?' I asked. 'Only a sixpence,' he replied, 'but if it's more I might get it from my father, who is watching the horses jumping.' I gave him a copy of the journal, as I thought that a boy who preferred to look at and read about engines to seeing horses jump was worth watching. He left me all smiles, and I saw him run over to his father and then settle himself down on a seat to read about engines, and I am sure he sat there for at least two hours.

"That was twenty-three years ago, Terry, and that was the shy little schoolboy who went out of this tent just now, and you know what he is now. Every year since then except during the war he has come to my show, and it's above fifteen years since he brought his father along and they bought their first little engine and plant to freeze fish at the back of the fish shop the father owned. You know where that boy is now; he has over seventeen thousands pounds' worth of our machinery in his ice and cold-storage plant, and today he tells me that he will be sending along very soon for another four thousand pounds' worth. If ever you start out to sell things, Terry, take my advice; start well down; never forget that the schoolboy of today may in the near future be the proprietor of a large plant, and the superintendent's office boy may soon, if he is interested, be filling the superintendent's job."

This advice of Old Frank can, I think, be followed by many in the power field, and the passing on of a catalog or journal may result in a rich reward.

My present office boy has my copy of *Power* for a couple of days each week, and I am sure that he devours every word from cover to cover. Some day it will benefit an advertiser. The boy with an inborn liking for machinery, whether rich or poor, is a prospective customer for the advertiser to encourage.

Belfast, Ireland. F. P. TERRY.

The Best Is the Cheapest

A successful salesman is one who knows his line and has the ability to sell his customers repeatedly in the face of the keenest competition.

The same line of reasoning with slight modifications may be applied to the man who buys. The art of buying is something more than the mere filling out of a requisition for cylinder oil or globe valves. There are a number of grades and qualities of cylinder oils and about 57 different varieties of globe valves.

To the engineer in charge of the power plant is usually delegated the duty of buying hundreds and possibly thousands of dollars' worth of supplies during the course of a year. How well he performs this part of his duty should be of vital interest to every engineer. The man who is really helping to build up his own reputation, as well as saving money for the firm that employs him, is not always the one that will buy or specify an article because he knows it is the cheapest of several on the market. At times the "economical" engineer will specify something "just as good" to replace an article that has been giving good service. It often proves to be rather expensive, and many engineers have learned this fact through bitter experience.

The cheapest is not always the best, but the best is usually the cheapest.

The man who is onto his job usually keeps abreast of the times in the matter of new and efficient equipment. One way of keeping informed of new developments is through the advertising pages of trade journals. Numerous other ways will suggest themselves to the progressive engineer.

In the majority of cases the engineer is not to blame for the policy so often adopted of saving at the spigot and wasting at the bung. It seems to be the ingrown tendency with many managers to consider the power plant as a necessary evil, something that must be endured as an adjunct to the process of manufacturing. It may never occur to the busy head of a company that the power plant is the main spring of his entire industrial system.

Take the boiler room, for instance. More money can be saved or wasted in this room in the course of a year than can be saved by the application of efficiency principles, etc., to any other department of the industry.

Tons of coal are wasted in many plants. A case in point is one in which the boiler room was erected a number of years ago. The boilers are of the water-tube type, the firebox and combustion space being designed to burn a good grade of Pittsburgh coal, at that time plentiful and cheap. In later years, however, this grade of coal has shut off that local market completely. At the present time western Kentucky coal of poor quality is the only fuel available at a price that is not prohibitive. The result is that the furnaces which were designed to burn high-grade coal are now being fired with a high-volatile coal. At each fresh firing the volume of black smoke that rolls from the chimney top is appalling. In the course of a year this black smoke represents many tons of coal wasted. The worst part of it is that the management of the plant is sanguinely indifferent to this willful waste. In this case the engineer is helpless to remedy the situation.

Consider the engine room. It is here that the effort to cut down on operating expenses is often tried out. Take cylinder oil, for instance. Good cylinder oil is expensive, yet it is poor economy to try out a cheap grade of oil on engines and equipment.

Recently, a large manufacturing company sought to reduce maintenance expenses. They found that they could buy a certain cup grease for about one-third of the cost of the grease in use at the time. The engineer in charge of equipment protested vigorously, but complied with the order to use the cheap grease. After three months' operation the following results were recorded: One month's run was sufficient to clog the eccentric on the large engine unit. The strap was so badly burned and grooved that it had to be rebabbitted. The oil groove in the strap had clogged completely. This trouble had never occurred with the high-grade grease. Out in the factory the same process was being slowly repeated on countless lineshafts. Already a number of bearings have been rebabbitted and considerable increase in the power consumption has been noticed due to increased bearing friction resulting from poor lubrication.

Packing is another article that is often grossly misused. Fortunate is the engineer who has the ability to use the right packing in the right place. The appearance of scored and ruined rods tells the story of misplaced packings. Fibrous packing will give good results when properly selected and intelligently used. Engine rods are usually packed with some form of metallic packing. Evidently, the manufacturers consider this the best type of packing for that service, and results seem to justify their judgment. It is a pity that more engineers do not use, and more managers be made to see the advantages of using, this type of packing wherever operating conditions will permit. Here again the high-price bugaboo will usually outweigh the advantages in favor of metallic packing.

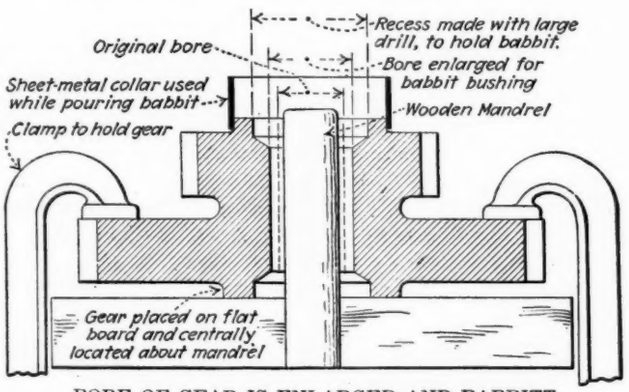
To the experienced observer a casual inspection of any power plant will reveal whether the engineer is looking to the future or only to Saturday night. Smooth running equipment, the absence of escaping steam around rods and valves and the orderly and well-regulated system of conducting the operation of the plant are usually a fairly good criterion of the class of engineer employed.

A. R. KNAPP.

Louisville, Ky.

Repairing a Worn Gear with a Babbitted Bushing

Normally, when repairs are made to the bearing of a gear or any part that turns on a spindle or shaft, a bronze or brass bushing is used. It is necessary to bore the gear to accommodate the bushing and also to turn the bushing from solid stock or make a special mold, pattern, etc., for casting, doing the turning work afterward.


Recess made with large drill, to hold babbit.
Original bore
Bore enlarged for babbit bushing
Sheet-metal collar used while pouring babbit
Wooden Mandrel
Clamp to hold gear
Gear placed on flat board and centrally located about mandrel

BORE OF GEAR IS ENLARGED AND BABBITT BUSHING RUN IN

In overhauling a pump recently, it was necessary to bush the reduction gear, and to avoid delay and unnecessary expense the method shown in the illustration was used. The hole was worn, and in consequence it was necessary to enlarge it. Instead of boring, it was enlarged by drilling; thus considerable time was saved. A wooden mandrel was made somewhat smaller than the spindle and placed in a flat board and the gear placed around it. A collar bent from a strip of brass was placed over the hub of the gear to aid in pouring the babbitt into the opening around the mandrel.

Babbitt was then poured, and afterward the gear was placed in the lathe and the center bored out. The operation with the babbitt bushing has been satisfactory so far, and should it be necessary to renew this at any time, the previous work will be shorter, as it will only be necessary to melt out the babbitt with a blow-torch and pour in another, thus saving time and materials over the use of bronze.

G. A. LUERS.

Washington, D. C.

Comments from Readers

Gage Should Show Pressure on Boiler with Water Column Shut Off

Referring to the article by M. M. Brown in the July 3 issue, entitled "A Word About Steam Plants," he shows a method of connecting a water column and steam gage to a boiler.

In my opinion this is not a practical method, because when the water column is shut off at night, the steam gage does not indicate the pressure on the boiler. He should be able to shut off the gage glass, also the high and low water alarm, without shutting off the steam gage.

W. H. WAKEMAN.

New Haven, Conn.

Suction Lift at Various Temperatures

In the issue of July 10 is an inquiry by H. T. regarding suction life at various temperatures, and while I agree that the chart shown gives safe values and well within good practice for boiler feeding and the like, I feel that one item has been overlooked. Actually in practice, I have seen hot water lifted much higher than the chart shows—even above the theoretical height.

This divergence between the theoretical and the practical is just another example of the statement that the two agree only when all the facts are presented. In the test referred to, the water was lifted by a water-operated ejector through an inverted U-shaped pipe, the top of which was 16 ft. above the surface of the water. The water was heated by a steam nozzle, and we were able to lift the water as hot as 200 deg. F. The only way I can explain this is that the water was in slugs, similar to the water in an air lift, the space between the slugs being filled with steam. Anyway, whether or not a vacuum corresponding to 16 ft. of water existed in the presence of water at 200 deg., the water was actually drawn up to this height and at this temperature.

Mt. Clemens, Mich. RUSSELL K. ANNIS.

Why Not More Poppet-Valve Engines in America?

The poppet-valve engine is to Europe what the Corliss-valve engine is to the United States. It seems to me that the engine builders of this country should go into making poppet-valve engines more than they do; in fact, as higher steam pressures, speeds and superheats are coming into use, it seems that the Corliss engine must give way to other types.

The first poppet-valve engine was built by Sulzer Brothers, of Switzerland, in 1865. It was an immediate success and is still the standard for engines having poppet valves. It had a layshaft and four eccentrics operating two admission valves on top and two exhaust valves on the bottom.

The principal advantages of the poppet valve are as follows: (1) No rubbing surfaces, therefore no lubrication is required and hence adaptable to higher steam temperatures; (2) small weight and practical balance, therefore adaptable to higher speeds and high steam pressures; (3) no wear, hence engine economy maintained for an indefinite period.

It is clear that the first advantage is apparent. The Corliss valve with its large rubbing surface must necessarily use large quantities of oil. The cylinder must in all cases be lubricated, but when the valve has a large rubbing surface, obviously more oil is required. In cases of superheated steam the item of cylinder oil is important, as ordinary oils decompose at the high temperatures. A Corliss-type engine cannot be used with steam superheated more than 100 deg., but this amount of superheat is practically worthless as it does not pay for itself. With poppet valves high superheats have been used successfully.

The weight of a poppet valve is only a fraction of one such as the Corliss, and the power required to operated it is consequently much less. At high speeds this fact is particularly noticeable as the Corliss valves and rocker arms possess considerable inertia.

The item of wear in the poppet valve and its seat is practically zero. In sliding valves, particularly with high pressures, the wear becomes appreciable and leakage may develop. A poppet valve, however, once properly ground in, should retain its seat indefinitely.

The poppet valve is simple. There are no heavy reciprocating parts, except the valve and valve stem. The present-day high cost of mechanical equipment makes it imperative to use high-speed engines, as in so doing generator cost can be lowered and considerable space saved. The higher speeds, say above 125 r.p.m., make trip gears undesirable as undue wear and noise take place. As a matter of fact the poppet valve produces a cutoff nearly as quick as the trip gear, making a trip gear unnecessary.

The main difficulty with the poppet valve is to design and construct it so that the valve and the seat will expand equally under an increase in steam temperature. In the case of a double-seated valve a slightly greater increase in expansion of the cage than of the valve will of course cause a leak under one seat. Where valves are made of cast iron this trouble has been largely overcome by designing the seat and the valve proper of similar shape and making the metal of equal thickness.

Valves have been designed which adjust themselves to any expansion of the seats. This makes valves and seats interchangeable. In Germany, for example, there is made a double-ported poppet valve for locomotive use, which is of pressed steel about $\frac{3}{32}$ in. thick, being pressed in two parts and welded together after it is assembled. The thin steel is flexible enough to adapt itself to slight inequalities of expansion.

The trend of the times in steam-power work points to higher pressures, superheat and speeds. Poppet-valve engines, whether of the unaflow or counterflow type, can meet these new requirements. They do not

have undue noise and wear. The economy of such engines is as good and often better than other types of engines working under the same conditions.

The poppet valve is not now a strictly new invention, but American engineers have not given it the thought and consideration it deserves. It is hoped that more manufacturers will give it their consideration as it is a step forward in the economical generation of power.

Cincinnati, Ohio. C. A. JOERGER,
Department of Mech. Engineering,
University of Cincinnati.

Air Compressor Got Red Hot

While reading the article by A. J. Lamie in the June 26 issue, describing the double air-tank explosion, it occurred to me that an experience we had some time ago may be of interest to *Power* readers. We have two compressors piped up to a receiver, one on each side of the tank, and each machine is not more than six feet from the tank. One is a two-stage 12x9x12-in. and runs at 165 r.p.m., while the other is a smaller single-stage machine and is used mostly as a booster to keep up the pressure, which is normally carried at 90 lb. The two-stage compressor is fitted with Corliss-type intake valves and mushroom poppet discharge valves and runs continuously with the exception of a couple of hours on Sundays and perhaps a day or two every three to four months.

One day recently I went home as usual at 5:10 p.m. One-half hour later I was called back because the compressor was red hot. When I arrived at the plant, I found that the discharge of the high-pressure side had actually been red hot and had extended along the connection to the tank for a distance of about three feet. The attendant who was in charge of the compressor shut it down immediately at the first sign of heat and, after cooling off the discharge pipe with water, started up the smaller machine, but the pipe got hot again, so he was forced to shut it down also.

After a little investigation I ordered the high-pressure cylinder opened up. Both heads were removed, and all the valves were taken out and thoroughly cleaned. This took about four hours. The machine was started up again and ran all right, and we have not had any trouble since. The man who stopped the compressor claims that the heat was traveling toward the tank very rapidly, and no doubt if the compressor had been left running a few minutes longer it would have reached the receiver.

It is my opinion that the heat was generated in the cylinder and ignited the carbon, which remained in a state of incandescence so long as the machine was kept running under the same conditions.

This is not intended as an interpretation of the causes of the double-tank explosion as described by Mr. Lamie, but of what actually occurred here. We try to keep the cylinders clean and free from carbon and as cool as possible, and we use the best oil the company will buy.

Some six months ago one of the poppet valves on the low-pressure cylinder of this same machine went through the head into the cylinder and was swept out by the piston, breaking the cylinder head, intake valve and crank disk. The low-pressure side was disconnected and service was maintained for two weeks by running the high-pressure side as a single-stage compressor, the unloader on the low-pressure side admitting air through the cylinder and intercooler into the high-pressure side.

I should like to have other readers who have had a similar experience express their opinions as to cause of the compressor's getting red hot. A. LACEY.

Selkirk, Man., Canada.

Reminiscences of a Veteran Mechanical Engineer

I have read with a great deal of interest the articles by W. H. Odell, entitled "Reminiscences of a Veteran Mechanical Engineer," and I should like to make a few comments on the Corliss pumping engines at the Hope station of the City Water-Works in Providence, R. I., as referred to in the article in the July 10 issue.

I remember Mr. Odell very well, as connected with the tests of Hope Street high-service pump, in the

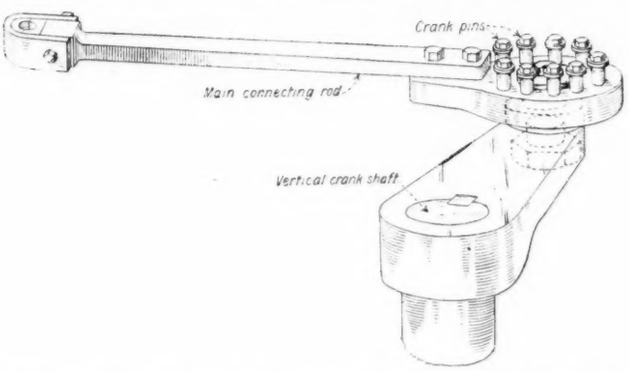


FIG. 1—THE MAIN CRANK PIN BEARING CARRIED NINE PINS CONNECTING THE OTHER CYLINDERS

winter of 1873-4, and his remarks on the character of Mr. Corliss are very pleasant and also just. Mr. Corliss had remarkable inventive ability as well as indomitable energy and courage to carry a project through. Like others who have those sterling qualities, he had many enemies, which originated more from jealousy than any fault of Mr. Corliss. To those who knew him well he was upright and kind-hearted to an unusual degree.

An incident of the latter trait may be interesting in these days of recklessness and bloodshed and non-value put in life. It was at a time a large engine or boiler was to be delivered by a specially large truck he had built for that purpose. It was found a robin had built a nest on it and was sitting on its eggs. His attention was called to it, and he immediately gave orders that the truck should not be touched till the brood was hatched and could look after itself, which probably cost Mr. Corliss many hundred dollars' delay. In this period of some weeks he would visit the truck daily to see how Mrs. Robin was getting on.

In regard to the arrangement of the Hope pumping engine, there was a vertical central crankshaft of the ordinary Corliss type with the exception that the crankpin which was uppermost had a removable flange on top to receive the eye of the main connecting rod, as shown in Fig. 1.

The large plate around the crankpin had nine studs on the upper face, spaced 36 deg. apart, that served as crankpins for the connecting rods to the other nine cylinders, as there were five steam cylinders and five water cylinders placed alternately around the crank-

shaft at equal distances. I never "got on to" the reason for placing engines and pumps alternately instead of five engines on one side and five pumps on the other, which would have made the piping connections much easier.

An unusual practice in those days was that the main crankpin and studs were all casehardened and ground, and the eyes of all the connecting rods at crank ends had hardened and ground bushings and of course no adjustments.

These were fitted a trifle too nice at first and gave some trouble. After two or three stops due to the too close fits, which of course was made large of by Mr. Corliss's enemies and to his annoyance, he gave orders to have all the bushings ground out $\frac{1}{64}$ in. larger than the pins. They never stuck after that, but when the engine was running anywhere near up to speed the knock could be heard a block away from the power house, and this was the condition at the time of the tests.

As to the near wrecking the engine by attempting to throttle the suction to equal a 20-ft. lift, it was simply a fool thing to do, and I am sure the committee were wiser after that experience and would never undertake such a thing again.

The engine had its governor gagged to cut off steam at not over one-eighth stroke, and the valves were closed by the old-fashioned weights and dashpots. This made a quick enough closing when the engines were not running over 27 r.p.m., but once the water column in suction was broken, the engine would go off many times faster and the weights would not close the valves

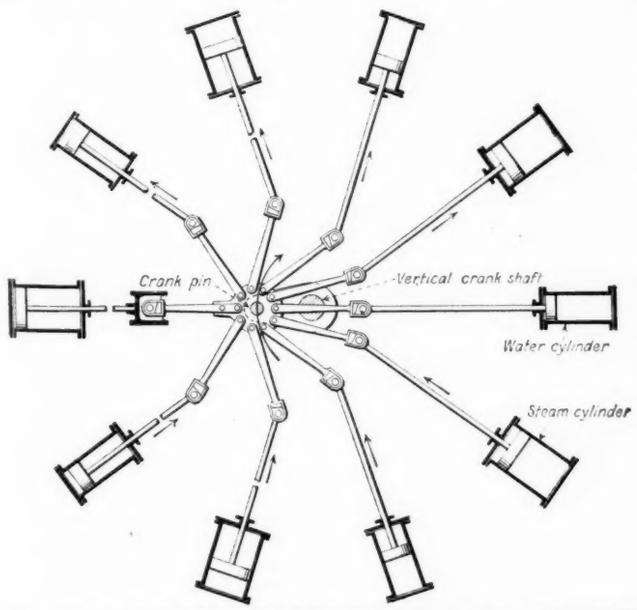


FIG. 2—FIVE STEAM AND FIVE WATER CYLINDERS WERE CONNECTED TO ONE CRANK ON A VERTICAL SHAFT

till very late or possibly not at all. Besides, the governor was of the old revolving pendulum type, and the engine without a flywheel was much too quick for it when the suction water was broken, so the engine probably made a half-dozen revolutions, till the governor acted, then stopped till the governor balls dropped, when off it would go again, and everyone was scared blue.

At the time of the tests on the Hope pumping engine, little was known of the workings of cylinder condensation and re-evaporation, and it was a rare schooling to me, who at that time was doing the indicating work and called the "engine Doctor" in the Corliss shops.

The steam diagrams, when running slow, were as shown in Fig. 3, and these fine Corliss engines when running slow were nearly as wasteful of steam as an ordinary steam pump.

Mr. Corliss did develop his small-unit boilers before he died, and he had a long battery of them to drive

FIG. 3—DIAGRAM OBTAINED WITH THE ENGINE RUNNING SLOW

the great beam engines in Machinery Hall at the Centennial Exposition at Philadelphia in 1876, but I do not recollect about rotary grates. That must have been after I left in 1878 to take up marine work at Bristol.

Bristol, R. I. NATHANIEL G. HERRESHOFF,
Herreshoff Manufacturing Co., Inc.

Place for Introducing Boiler Compound

Having read the inquiry of E. M. in the July 10 issue regarding the proper place to introduce boiler compound, will say that I believe that it depends largely on the type of heater. If the heater is of the pressure type then it is right to pass the compound through it, but if of the open type the compound should not be passed through the heater, for these reasons:

If the compound is composed of vegetable matter or ground barks, etc., some of it will be filtered out. This then will mean a loss and the desired results will not be obtained. Again, if it passes through the pumps it may cause some troubles there, as it will act on some packings and some classes of compounds will be likely to make the pump groan at times, especially if the compound is of the soda or caustic class.

As to the method of feeding I have found that the best possible way is to feed the compound continuously, and there is no better method than to attach some make of independent pump to the drips of the boiler feed in such a way that the compound pump is actuated by the varying pressures of the boiler-feed pump and forces compound into the line close to the boilers. In this way the boilers get the quantity needed, depending on the evaporation, all being governed by the speed of the feed pump, and all the water as it is passing to the boiler gets a certain amount of compound.

Many a good compound, because of improper handling and method of feeding, is not doing the work it could and would do. In many cases much better results would be obtained if the compound were fed according to directions instead of a big dose today and none tomorrow or a little when convenient.

Then, after having introduced it, follow it up by the proper handling of the boilers, which means the use of the blowoff. This may not mean the blowing down of any determined amount, but as the conditions of the boiler demands; but blow regularly, and a good plan is to give a boiler a short blow three times a day. This will remove the sludge and prevent the accumulation of scale.

ASA P. HYDE.

Binghamton, N. Y.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Strength of Butt Joint with Single Strap

What advantage has a butt joint for a boiler shell with a strap on one side? W. P. W.

When there is a single strap or cover plate attached to the main plates by ordinary lap joints, there is no greater advantage of strength than lapping the plates themselves, because such joints consist essentially of two lap joints in immediate proximity to each other and are subject to the same distortion from eccentricity, unless there is sufficient thickness of the cover plate to prevent bending.

Emulsification of Lubricating Oil

How does emulsification of an oil injure its lubricating properties? F. R. A.

Emulsification of the oil consists of the suspension of minute oil globules in water. The condition prevents formation of a continuous oil film between the surfaces to be lubricated. Hence reliance cannot be placed in the lubricating or cooling effect of oil in an emulsion or where emulsification is likely to occur from mixture of the oil with wet steam or condensate. In addition to impairment of lubricating properties from breaking up of the oil, when there is emulsification in an oiling system dirt and foreign matter do not settle out readily.

Pressure on Sides of Water Tank

We have a tank 12 ft. in diameter and 12 ft. high made of ⅛ in. thick corrugated galvanized steel. It is proposed to use this tank for storage of 8,000 gal. of distilled water. What will be the pressure acting on the sides at the bottom and the probable factor of safety? F. D. O.

The horizontal cross-sectional area of the tank would be $12 \times 12 \times 0.7854 = 113.1$ sq.ft. For one foot of depth there would be $113.1 \times 7.48 = 845.988$, or practically 846 gal.; the depth containing 8,000 gal. would be $8{,}000 \div 846 = 9.45$ ft., and for that depth of water the pressure at the bottom would be $9.45 \times 0.433 = 4.09$ lb. per sq.in. As the tank might become filled to full depth, it should be capable of resisting a pressure at the bottom of $12 \times 0.433 = 5.2$ lb. per sq.in. The resistance to internal pressure would depend on the strength of the longitudinal joints. Cold-riveted joints, made as usual in work of this kind, would have an efficiency of about 40 per cent of the strength of plain plates of the same thickness. Allowing a tensile strength of 55,000 lb. per sq.in. of cross-section and a joint efficiency of 40 per cent, the longitudinal joints would be capable of resisting $\frac{1}{8} \times 55{,}000 \times 2 \times 0.40 \div (12 \times 12) =$ about 19 lb. per sq.in., and for the highest pressure the factor of safety would be $19 \div 5.2 = 3.6$.

Factor of Evaporation with Economizer

In determining the factor of evaporation when using an economizer, is the figure to be based on the temperature of water in the outlet of the economizer or temperature of water leaving the feed-water heater? A. L.

If the factor of evaporation is intended to apply separately to boiler performance, it should be based on the temperature of water as received by the boiler from the economizer. If the factor is to apply to the combined performance of the boiler and economizer, it should be based on the temperature of feed water as received by the economizer, and the performance should be distinctly designated as combined evaporation of boiler and economizer.

Cause of No-Voltage Release Coil on Compensator Burning Out

On a compensator for starting a three-phase motor driving a pump the no-voltage-release coil has burned out twice in two months, but I have been unable to find any cause for the trouble. What would likely be the cause of the difficulty? B. A. E.

There are a number of things that might cause the coil to burn out. First, the starter may be connected so that the no-voltage-release coil is in the circuit all the time the line switch is closed. In such a case, when the starter is in the off position, the no-voltage-release coils magnetic circuit is open, which would cause the coil to take an excessive current and burn it out in a short time. The current in the coil is limited by the ohmic resistance of the coil, which is comparatively small, and by inductance. If the magnetic circuit of the coil is open, the inductance is low and allows an excessive current to flow.

There may have been a short-circuit developed in the coil due to faulty insulation and vibration. The latter is always present in alternating-current magnets to a greater or less degree. A short-circuit in the coil would have an effect similar to that of a short-circuit in a transformer. Another cause of the trouble might be the movable part of the magnet out of alignment, so as to prevent the magnetic circuit from closing properly. This would have a similar effect to the first cause. A fourth cause is excessive line voltage. However, this is doubtful unless a mistake has been made in the shop and a coil designed for a lower voltage, than the rated line voltage of the compensator installed on the starter. Such things have happened, and it might be a good idea to write to the manufacturers and find out the size of wire used on the no-voltage release coil of starters of the serial numbers and voltages that you have.

Mills Rule for Figuring Radiation

What does the rule or term "2 — 20 — 200" signify when applied to heating problems? A. B. H.

The rule 2 — 20 — 200, commonly called the Mills rule, is one of the more simple rules for determining the amount of radiation surface required for steam heating each room of a building; that is, for steam heating allow one square foot of radiation for each 2 square feet of glass, one for each 20 square feet of exposed wall surface and one for each 200 cubic feet of room content, and for hot-water heating add 60 per cent to the amount of radiation required for steam heating.

Increasing Speed by Loading Governor

The steam valves of our single-eccentric Corliss engine are operated by a single rod from the governor. Is there any way of increasing the speed of the engine without changing the size of the governor receiving or driving pulley? J. A.

Most Corliss engine governors are provided with means for varying the dead weight that is balanced by the centrifugal force that acts on the governor balls. By increasing dead weight, the engine will be regulated to a higher speed because, for a given load on the engine, a higher speed of the governor is necessary to bring the governor to a position that will limit the cutoff to the m.e.p. required by the load. The maximum speed thus provided for by the builders of the engine is supposed to be within the safe speed for the engine and within the speed at which the cutoff mechanism will operate. If it is decided that the proposed speed would be safe, the suitability of the cutoff should be tested by loading the governor temporarily, but in such a manner that the loading can be quickly withdrawn should the cutoff fail before the desired speed is obtained.

Higher Feed-Water Temperature at Expense of Back Pressure

We have a 20 x 48-in. non-condensing engine, running 80 r.p.m., supplied with steam at 110 lb. boiler pressure. The average load is 322 i.hp. and present back pressure 2 lb. By increasing the average back pressure to 4 pounds, we are able to increase the feed-water temperature from 160 to 180 deg. F. What would be the percentage gain or loss of economy? R. N. D.

The horsepower constant of the engine is 6.0928, and the required m.e.p. is $322 \div 6.0928 = 52.85$ lb. To increase the back pressure from 2 to 4 lb. would require about as much additional steam as to increase the load $6.0928 \times (4 - 2) = 12.186$ i.hp., or about 3.8 per cent.

The total heat of a pound of steam at the pressure of 110 lb. gage, or 125 lb. per sq.in. absolute, is 1,190.3 B.t.u. For generation of steam at the stated pressure, from feed water at the temperature of 160 deg. F., each pound must receive $1{,}190.3 + 32 - 160 = 1{,}062.3$ B.t.u.; and with the feed water at the temperature of 180 F., each pound would receive 20 B.t.u. less, or 1,042.3 B.t.u. Hence the amount of heat required of the fuel with 2 lb. back pressure would be to the amount required when the back pressure is raised to 4 lb. as 1,062.3 to $1{,}042.3 \times 1.038$, or as 1 to 1.0184; that is, under the conditions, to increase the back pressure 2 lb. would require about 2 per cent more fuel for development of the same power.

Steam Output with Different Coals

Recently, we gave two different kinds of coal each a week's trial. Of the first lot we were required to use 50,821 lb. for service of 257,200 lb. of steam, and of the second lot we used 60,894 lb. for service of 276,625 lb. of steam. Assuming that all operating conditions were the same, what greater or less percentage of steam was furnished per pound of coal when using the second lot of coal? C. M.

When using the first lot of coal there was $257{,}200 \div 50{,}821 = 5.06$ lb. of steam furnished per pound of coal; and when using the second lot there was $276{,}625 \div 60{,}894 = 4.54$ lb. or only $\frac{4.54}{5.06} = 0.897$ as much. Hence, the second lot of coal furnished 10.3 per cent less steam per pound of coal.

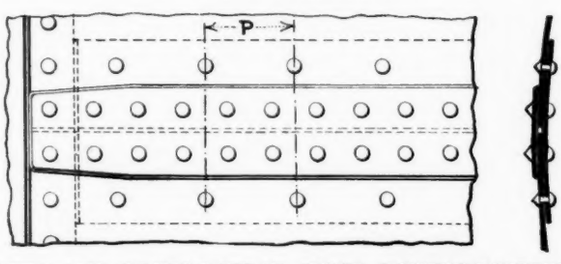
Airbound Water-Pipe Line

Our plant is supplied with drinking water and water for washing out boilers by a 2-in. pipe line that is about 1,000 ft. long. Frequently, after washing out a boiler, the pipe line becomes airbound and some time is required before the flow can be re-established. The source of supply is a small reservoir kept filled with water from a spring which is about 50 ft. higher than the boiler-house floor, and there is a crest in the pipe line that is about 12 ft. lower than the level of water in the reservoir. What causes the pipe line to become airbound and how can the trouble be prevented? L. F.

Under atmospheric conditions water contains air in solution that becomes disengaged by reduction of the pressure, such as occurs during flow through bends or from siphoning the water over a crest in a pipe line. The trouble usually can be overcome by having air vents only at the highest points in the pipe line. Automatic air valves are made for this purpose, but their use generally is confined to large pipe lines such as required for municipal water-works.

Place a small air vent in the top of the pipe at the crest of the line and leave the vent open a very little all the time. This will cause nearly constant waste of a small flow of water, but if such a loss is objectionable, connect the vent with a small open standpipe raised to a higher level than the level of the water in the reservoir.

Butt and Double-Strap Joint, Double Riveted —A Correction



BUTT AND DOUBLE-STRAP JOINT, DOUBLE-RIVETED

In the July 24 issue, page 151, the item "Efficiency of Butt and Double-Strap Joint, Double-Riveted" was wrongly illustrated from the use of a drawing of a triple-riveted joint. The illustration should have been the one here given.

Easy Lessons in Engineering

How to Test a Boiler

There are many kinds of boiler tests. Like any other piece of apparatus a boiler may be tested to find out anything about it that the man in charge may wish to know. As a rule, however, the principal object is to determine the over-all performance under a given set of conditions. This performance may be expressed in terms of actual weight of water evaporated per pound of coal, in terms of over-all efficiency or in various other ways.

To make the performance figure of value, it is necessary to have a record of the conditions under which it was obtained. These should include, at the very least, the kind of fuel, method of firing, the draft through the fuel bed and the load on the boiler.

If the purpose of the test is to set a high-water mark with which every-day operation may be compared, the boiler is first put in first-class condition (thoroughly cleaned, setting made tight, leaks stopped, etc.). It is then operated with the greatest skill and care throughout the test.

Only a few quantities need to be measured to determine the over-all efficiency of a boiler. They are: Weight of water evaporated, feed-water temperature, steam pressure and condition, weight of coal fired, and calorific value of coal (B.t.u. per pound as fired).

The output in heat units is figured from the steam and water data, while the input is figured from the weight of coal and its heat value. The efficiency is then the output divided by the corresponding input. The steam and water data also give the load which with a record of the draft and method of firing forms the complete data for the performance of the boiler as a whole under a given set of conditions.

In elaborate boiler tests many "secondary" measurements are made. These include: Flue-gas analysis, flue temperature, room temperature, weight of ash, percentage of combustible in ash, etc. None of these enters into the computation of the over-all efficiency or the load carried. They are used for computing a "heat balance" showing just where the various losses occur.

It would be impossible in an article of this length to explain satisfactorily how such an elaborate test is carried out or how the computations are made, so we will go to the opposite extreme and stick closely to the absolute essentials for a simple efficiency test.

The most difficult matter in any boiler test is to determine accurately the weight of coal actually burned and the weight of water evaporated. This difficulty arises chiefly from the fact that the water level and the fuel-bed condition may not be exactly the same at the start as at the finish. The greatest care must be taken to have them as nearly as possible the same at these two times. Before the test is started, the boiler should have been in operation for some time under the test conditions. The fire should be cleaned about half an hour before starting and the same time before stopping. The water levels at the start and finish should be marked on the gage glass, any difference being reduced to pounds weight and allowed for in figuring the weight evaporated. Great care should be taken to have the fire of the same thickness and in the same general condition at the start and finish. Any difference should be estimated and allowed for. Before the test is started an estimate should be made of the possible differences in the weight of coal at the start and finish that could not be detected and allowed for. This generally determines the length of the test.

The coal fired may be weighed in wheelbarrows and then dumped on the firing floor. The weight of water evaporated is best determined by drawing all the feed water from a tank supplied intermittently from a weighing tank mounted above it on platform scales.

Sampling of the coal for analysis is an important matter which should be carried out in some standard manner such as that laid down by the United States Bureau of Mines and described in various engineering handbooks. The feedwater temperature should be determined by means of a reliable thermometer placed in a thermometer well in the feed line close to the boiler. If the boiler has a superheater, the steam temperature should be read from another thermometer at the superheated steam outlet. Where the steam is saturated a calorimeter should be used to determine its moisture, although in the absence of a calorimeter an arbitrary allowance of 2 per cent of moisture is sometimes made. The thermometers and steam gage should be tested before the boiler test begins.

Before the test is started, several log sheets should be prepared with headings as follows:

Log Sheet I		Log Sheet II		Log Sheet III			
Time	Weight of Coal	Time	Weight of Water	Time	Feed Temp.	Steam Temp.	Steam Press.	Draft

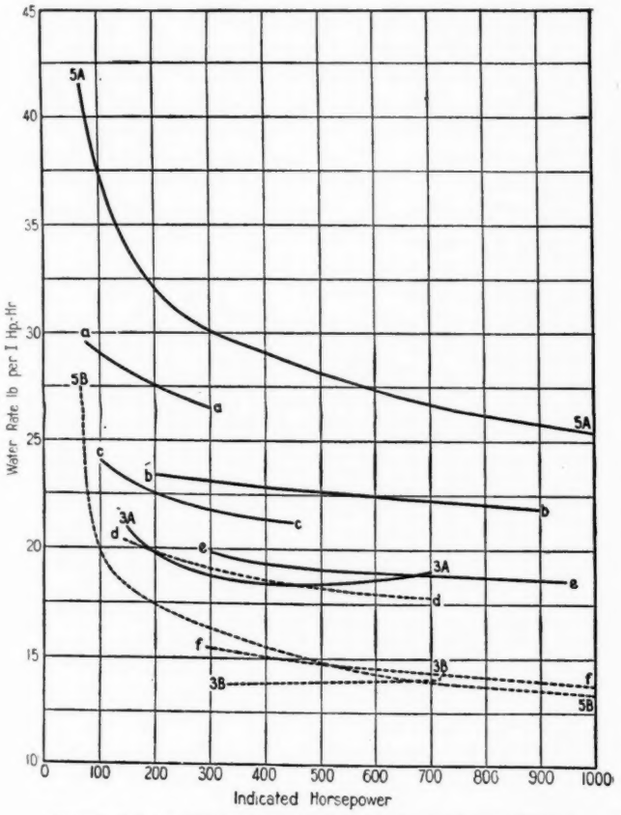
The keeping of these logs will require three men. The time entries on the first two will come of course at slightly irregular intervals, but the data on log-sheet III should be entered at regular intervals, say 15 minutes. If the test goes without a slip, only the totals are needed, but the systematic entries act as a check on errors and permit cutting out any portion of the test in which a slip is made.

Assuming no slip is made, the columns are totaled, the temperatures and pressures are averaged and the weights divided by the length of the test in hours to get the coal fired and water evaporated per hour. Next, the weight of water (total or per hour) is divided by the corresponding weight of coal to get the evaporation per pound of coal. From these data the boiler efficiency is easily computed as explained in the article "How to Use the Steam Tables"—II, in the August 7 issue.

Railway Power-Plant Notes

In the division on Power Houses of its report submitted at the annual convention held on June 20 to 22, Chicago, the committee on Design of Shops and Engine Terminals of the American Railway Association presented a summary of previous reports of the Committee on Modernization of Stationary Boiler Plants, condensed and brought up to date. Certain portions of this condensed summary appear in the following:

In railway power plants the following types of boilers are generally employed: Locomotive type, Scotch marine, horizontal return tubular and water-tube boilers. Locomotive-type boilers have an advantage in small railway



FULL-LOAD WATER RATES OF VARIOUS TYPES OF PRIME MOVER

(a) Automatic, single cylinder, non-condensing, ¼ cut-off, 125 lb. gage. (b) Medium speed 4-valve, non-condensing, ¼ cutoff, 130 lb. gage. (c) Automatic tandem-compound, non-condensing, ¼ cutoff, cylinder ratio 4 to 1, 140 lb. gage. (d) Automatic tandem-compound, condensing, ¼ cut-off, cylinder ratio 4 to 1, 140 lb. gage, 26 in. vacuum. (e) Medium speed 4-valve compound, non-condensing, ¼ cutoff, cylinder ratio 4 to 1, 150 lb. gage. (f) Medium speed 4-valve compound, condensing, ¼ cutoff, cylinder ratio 4 to 1, 150 lb. gage, 26 in. vacuum. (3A) Unaflow, non-condensing, 1¼ to 2 lb. back pressure, 100 to 135-lb. gage. (3B) Unaflow, condensing, 125 to 135 lb. gage, 26 in. vacuum. (5A) Turbine, non-condensing, 150 lb. gage, kw. and kw.-hr. reduced to i.hp. and i.hp.-hr. (5B) Turbine, condensing, 150 lb. gage, 28 in. vacuum.

power plants as these boilers are often obtained from dismantled locomotives and the cost of installation is small.

Horizontal return-tubular boilers also are comparatively inexpensive, especially the installation. The advisable limiting size of locomotive and horizontal return-tubular boilers is 150 hp. and the highest boiler pressure 150 lb. When more than six locomotive or return-tubular boilers are in one installation, it is desirable to consider water-tube boilers of larger capacity per unit. The relative evaporative efficiencies of locomotive, return-tubular and water-tube boilers are given in Table I.

With stokers, overhead coal bunkers and mechanical ash conveyors, one man can look after from five to eight times the boiler capacity that he could with hand firing and hand ash disposal. Therefore, with all factors considered, such as reduction in boiler-room force, greater capacity of boilers, interest and depreciation on investment, etc., it is believed that plants having 1,000 hp. and over should have stoker-feed boilers, and under certain conditions profit may be shown with stoker-feed boilers in less than 1,000 hp. The type of stoker to be used depends on the fuel available and the method of conveying it into the power plant. Table I also gives the comparative efficiencies of stoker- and hand-fired boilers.

Owing to the fact that at the majority of shops and roundhouse facilities, exhaust steam is used for heating buildings and also steam boilers must be maintained to furnish live steam to the roundhouse steam blower line, the prime movers are mostly steam driven. In a few cases

TABLE I—COMPARATIVE EVAPORATIVE EFFICIENCIES OF BOILERS

	Water Evaporated per Pound of Comb. f. and a. 212 deg. F.	
	Hand-Fired	Stoker-Fired
Locomotive type	4 to 6.5	.....
Return-tubular type	5.5 to 9	6 to 10
Water-tube type	7 to 10.5	8 to 12

it has been found advantageous and economical to install gas or oil engines, but so long as steam locomotives must be operated, the steam-power plant will likely predominate.

The determination of what particular kind of steam engine shall be employed requires careful analysis, as local conditions largely govern, such as floor space available, amount of exhaust steam needed for heating, required unit sizes of generator and whether the plant is to be operated condensing or non-condensing. In general it may be said that in units up to 250 hp. operating with

TABLE II—ESTIMATED MONTHLY COST OF STEAM, AIR AND WATER LEAKS

Steam

Size of Leak or Sum of Several Leaks, Diam., In.	Steam Pressure, Lb. 60	120	150	200
⅛	$2.98	$5.26	$6.44	$8.24
¼	11.86	21.02	35.74	33.00
⅜	57.46	84.04	102.96	132.02
½	189.90	336.10	411.86	528.08
¾	427.50	756.10	926.50	1,187.96
1	759.62	1,344.44	1,647.44	2,112.34

Air (Pressure 100 lb. per sq.in.)

Size of Leak or Sum of Several Leaks, Diam., In.	
⅛	$5.78
¼	23.18
⅜	92.72
½	370.90
¾	835.00
1	1,483.64

Water (Pressure 100 lb. per sq.in.)

Size of Leak or Sum of Several Leaks, Diam., In.	
⅛	$12.00
¼	48.00
⅜	192.00
½	768.00
¾	822.00
1	3,072.00

the exhaust steam used for heating, reciprocating engines are the most desirable. If during the season when steam heat is not required and at the same time fuel must be conserved, unaflow engines may be considered. Also, if circulating water is available, the engines may be run condensing. The accompanying chart gives comparative steam consumptions per indicated horsepower-hour.

In units of above 250 hp., except in special cases, steam turbines are preferable. It will be noticed that in order to secure reasonable economy, steam turbines must be run condensing.

As to maintenance, this depends largely upon local conditions, but in general steam turbines require less maintenance than reciprocating engines, but when repairs are necessary, the services of a specialist, not always available in railroad organizations, is required. The railway-shop machinist is usually capable of making repairs to the reciprocating engine.

Unless steam, air and water leaks are carefully watched, they will be the source of great expense. With coal costing $4 per ton and water at 8c. per 1,000 gal., Table II shows the losses that may be anticipated.

According to the report of the British Electricity Commissioners, quoted in *Engineering*, there are 536 central power stations in England, of which 396 are steam driven, 60 producer-gas plants, 52 use fuel oil and 28 derive their power from waste heat, town gas or water. Of these stations only nine have an annual output exceeding 100,000,000 kilowatt-hours.

News in the Field of Power

Mr. Harding's Death May Affect the Coal Situation

The death of Mr. Harding comes at the worst possible time in so far as it affects the coal situation. While those who are in a position best to appraise the situation are convinced that there will be no strike, they must admit that the situation is one in which a crisis might develop at any time.

Enough has been learned in the last few years of government intervention to make it very clear that it is a diplomatic rather than an executive undertaking. Such a task can be undertaken only by a person in whom each side has confidence. Whatever may be said about Mr. Harding's greatness as an executive, no single individual in the land will dispute that he was a man of friendship—a man with an intense desire to do the right thing. He commanded the respect of capital and labor alike because they knew he was bighearted and would do his best to be fair, and the public would have been satisfied with his mediation.

The situation at present is complicated by lack of knowledge as to what the new President may do. The outstanding achievement of his career is his handling of a labor matter. His action at Boston in connection with the strike of policemen brought him into national prominence and secured for him the praise and support of those who believe a firm stand must be made against the exactions of labor unions. That act, however, antagonized labor. It is certain the United Mine Workers would hesitate a long time before they would agree to accept President Coolidge as final arbiter of questions which to them seem vital. Unquestionably, labor unions are not at all sure but that one of the principal opponents of their policies has been elevated to the presidency.

On the other hand, many think Mr. Coolidge will take this opportunity to demonstrate that he is not opposed to labor unions when properly conducted. He may admit the right of the United Mine Workers to demand all that they have and to strike if they do not get what they ask. At best, however, it is admitted on all sides that the prospects of agreement is less auspicious today than it was.

The Supplementary Report of the Coal Commission Suggests Points for Help Toward Peace

Suggests Presidential Intervention in Case of Stoppage, More Efficient Organization of Operators, Better Service by the Union to Its Members and an Umpire for the Board of Conciliation

THE supplementary report of the United States Coal Commission, released last week, deals with labor relations in the anthracite industry, and many recommendations are made for bringing about peace in that industry.

The outstanding recommendation is that the President should have the right by law to intervene and to make an effort to prevent a general strike. There is also a declaration that compulsory arbitration is not a remedy. The report is briefly summarized as follows:

We find that the agreement between the operators and the union, which has been in effect since 1903 is very widely accepted in principle by both sides, but is carried out in performance very inadequately. We find strikes in violation of the agreement. We find delays in the consideration of disputes a serious handicap to satisfactory working; we find that there is not enough specialized provision for the consideration of specific disputes right on the ground and at the mine where such disputes arise, and we find in the handling by employers of the early stages of disputes too great a disparity of practice and viewpoint.

Proposals for Next Agreement

The next agreement shall run for such periods as may be agreed upon and at the end of such period shall be considered to have been renewed except in respect to such provisions as either party may have expressed a purpose to change by serving notice of such purpose on the other party ninety days before the renewal date.

Upon these points the parties shall immediately confer, and if within sixty days of the renewal date they have been unable to agree, the agreement shall provide that they report the fact of their inability to agree and the issues upon which they cannot agree to the President of the United States. It is recommended that the President thereupon appoint a person or persons to inquire into the reasons of the failure to agree and make public a report before the renewal date.

We recommend further that the renewal date of the anthracite agreement shall be set sufficiently far from the renewal date of the bituminous agreement that suspension in both industries at once shall not be invited.

Many additional points are suggested for the next agreement, which deal chiefly with the organization and workings of the Conciliation Board: The presence of a "continuing umpire or an assistant to him, sitting at all meetings of the Conciliation Board"; the clarification of nomenclature, such as, what is meant by "a day's work" and the rates for it, what work is expected under different "jobs"; elimination of the long day; the exercise of power of discipline.

Better Organization of Operators

The operators have no organization for dealing directly and continuously with the union during the agreement period. There are two general operator associations, the Anthracite Coal Operators' Association, consisting of independent operators, and the Anthracite Bureau of Information, to which both "railroad" companies and independents belong. Neither of these organizations deals directly with labor matters. For negotiation with the union at the expiration of the agreement and to act as general spokesman of the operators, a General Policies Committee exists which consists of fifteen operators from the two.

Within the districts there is no organization of operators whatsoever. The operator members of the Conciliation Board are selected one from each district at a special caucus of the operators of that district, but the individual company remains the unit of administration in dealing with the union.

The first of the important causes of friction discussed in the report is the attitude toward the agreement. Both operators and union officials, it is said, believe in the agreement and out of more than fifty responsible operator executives interviewed only two were opposed to the idea of an agreement with the union. Many criticized the way the agreement was working out, opposing certain features, condemning the policies and practices of the union, but the consensus of opinion was that they were better off with the agreement than without it.

Union's Field of Service

The union stands in a relation to its own members which implies a service beyond the mere activity of grievance and strike committees. If the union is wise it will not permit the employer to take over the duty of securing members, thus shutting it off from a responsibility and a contact with the rank and file that in the long run must be the source of its vitality. By close, continuous, and effective educational contact it must steadily build up the calibre of all its leaders, and greatly increase attendance at its meetings.

Habitual resort to petty strikes

means sacrificing a real authority based upon recognition of work for a temporary authority based on force and threats of force which the nation will sooner or later be obliged to curb. The national union must daily serve the anthracite industry or expect dissension and secessions. The district organization must afford a control which enforces the agreement, or expect the public to provide an enforcement more mechanical, less expert, and less sympathetic.

It is stated that "when the union in the eyes of the people shall have had the chance and failed, there will be almost no escape from resort to legal methods."

The report continues:

But the operators have similar obligations and opportunities. The operators may aid in making public resort to legal methods unnecessary. They are in a position to harvest the experience in their own and in other industries and, in the light of that experience, to concentrate dispassionately on the best methods of adjusting practice to the real psychology of men at work.

In the systematic cultivation of their relations with their own employees, in the selection and development of leaders of men as foremen, in continuing the education of men in management, and in organized efforts to build internal good-will—the operators have an opportunity to strengthen all normal motives toward co-operation and thus to weaken the forces making for strife. The dominance in the anthracite fields of the large company with all its chance for concentration of responsibility for labor relations upon some high official, offers every opportunity and hope, if the will be there.

Primarily, it is the growth of a better spirit and a better partnership the industry needs, and we see no hope of encouraging such a growth by punitive legislation. The foregoing suggestions for changes in administration on both sides have not been given too hard and fast a form. The men of the industry should know better than we the precise form which measures necessary to progress should take. Both parties, however, must lay stress upon the fact that the American people will expect much.

The Subject of Strikes

The great strike of 1902 brought about a coal famine just as the approach of winter and was only ended by the vigorous action of President Roosevelt after there had been widespread suffering. Since then public anxiety has been aroused by general strikes or suspensions in 1906, 1912, 1920 and 1922; some of the cessations have occasioned serious hardship. The approaching expiration of the agreement between the anthracite operators and the United Mine Workers again puts that part of the national fuel supply in jeopardy.

The frequency with which labor trouble has stopped production of anthracite coal, the disregard of public interest shown on occasion in the attitude of one or the other of the parties to these controversies, and the apparent impotence of the public to protect itself has created a situation that the public considers intolerable. In search for a remedy certain citizens are advocating even so drastic a measure as nationalization of the mines while others are insisting on compulsory arbitration and outlawry of strikes. The demand for some sort of remedial public action is practically universal.

President Roosevelt in 1902 asserted vigorously the public interest in anthracite mining; public sentiment ever since has approved his stand. The Anthracite Coal Strike Commission appointed at that time laid the foundation for machinery that is still functioning. This machinery operates under collective agreements between the operators and the union and, except at the times when agreements expire, has maintained approximate peace in the industry. Collective bargaining with partial public participation is, therefore, an established fact in anthracite mining.

Periodic strikes and the ever recurring menace of strikes emphasized by loose militant utterances on both sides is a condition that should be corrected, if correction is possible.

Alberta Coal To Compete with U. S. Anthracite in Canada

As an experiment in competing with costs of anthracite shipped from the United States, 6,000 tons of Alberta coal will be sold in Toronto at $12 a ton, it is announced. H. Greenfield, the Premier, said a freight rate of $7 per ton had been fixed in the experimental shipments to Ontario over the Canadian National lines.

The Alberta coal price in Toronto compares with $15.50 asked for United States anthracite there, or $3.50 less per ton according to the *Christian Science Monitor*.

40,000-Hp. Turbine Installed in England

A 40,000-hp. generator, the largest power-generating unit in the United Kingdom, according to the *Mechanical World*, was started on May 28 by H. R. M. the Prince of Wales at the electricity works of the Rotherham Corporation. This generating set comprises a 40,000-hp. turbine, running at 1,500 r.p.m. driving a 30,000 kw. 6,600 volt generator. Both the steam turbine and the electrical generator were designed and built at the Rugby Works of the British Thomson-Houston Co., Ltd. The power station in which this generating unit is installed supplies, in addition to other customers, the large modern steelworks in the district, which are operated entirely by electricity.

Recommends House Heating from Exhaust Steam

The Springfield Engineers' Union has recently finished its survey of the power situation in New England and has made a comprehensive report, which includes a plan for power economies, to the Associated Industries of Massachusetts. The survey parallels a study being conducted by the Power Investigating Committee of the Associated Industries.

The plan proposed by the labor union committee urges the district heating of homes by connecting them to the steam exhaust pipes of the power plants and so making heat a byproduct of the manufacture of electricity.

Coal must be used to make electric power, but it must be used more efficiently than it has been used, they insist. The labor men declare that their proposal to utilize exhaust steam for whole districts in congested parts of cities would result in the vast savings of coal. Fully 50 per cent of all coal used in New England could be saved by the adoption of their plans for more efficient generation of electric power and full use of all heat that is incident to power generation by coal burning, they assert. The engineers' figures show costs of municipal operation to be only one-third of the costs of private operation.

The report of the Fuel Investigating Committee appointed by the Associated Industries will be ready in the near future.

Water-Power Projects

The City of Los Angeles has been denied rights on the Kings River by the Federal Power Commission. This proposed development is in the area suggested for inclusion in the Roosevelt National Park. The commission also has voted to reject the application of the San Joaquin Light & Power Corporation for rights on Bubbs Creek and on Roaring Fork.

Permission has been granted the Alabama Interstate Power Co. to transfer to the Alabama Power Co. the license covering its Cherokee Bluffs development.

The Commission has authorized the issuance of preliminary permits as follows:

The Yosemite Power Co., Groveland, Calif., two developments on the Tuolumne River. The application for permit covering a lower site was denied since it might interfere with the Hetch-Hetchy water rights.

The Susquehanna Power Co., of New York, covering the proposed 360,000-hp. development on the Susquehanna at Conowingo.

The Marianna Light & Power Co., of Marianna, Fla., has announced its intention to develop a power project in the Chipola River, near Marianna. The Commission has accepted jurisdiction.

The Cumberland Hydro-Electric Co., recently organized in Indianapolis, which holds options on valuable Cumberland River rights in southeastern Kentucky, has applied to the Federal Power Commission for preliminary permits covering three projects on that stream. The Cumberland company has entered into a contract with the Middlewest Utility Co., (Samuel Insull), of Chicago, with the idea of carrying out the Kentucky development, which is an important adjunct to the utilization of the power that will be developed by the new government dam at the Falls of the Ohio.

The Middle West Co. has properties in Kentucky and in Indiana, which are in a position to absorb the power that will be made available.

New Publications

Atlas of U. S. A. Electric Power Industry, Outlining Suggested Regional Power Districts and Proposed Constant Potential Transmission Systems for the United States of North America. By Frank G. Baum, consulting hydro-electric engineer, San Francisco, Calif. Published by McGraw-Hill Book Company, Inc., New York, 1923. Cloth, 17x11 in.; 18 pages of text, 34 full pages of illustrations. Price, $10.

This gives a vivid picture of the proposed superpower system, with the reasons for its formulation. Of the three divisions of the atlas, the first deals with the suggested districts, present and future transmission lines, available fuel, water and steam power, markets, etc., showing the general problem and its solution. Part two takes up the mathematical and analytical phase of the question, such as determining the transmission lines and distribution systems. Part three contains ten pages of illustrations showing conditions of fuel supply and consumption, water power, rainfall, etc., for the United States and the world. It is stated as being possible to double the business of the public utilities in about five years, with the business in sight. This will require additional investment of about $5,000,000,000 and will result in an yearly revenue of about $1,000,000,000. The annual saving to consumers will probably be more than the gross revenue of the utilities, including 200,000,000 tons of coal and labor, representing 500,000 men.

Obituary

P. J. Lough, superintendent of power and distribution for the Monongahela West Penn Public Service Co., in the Mannington district, Fairmount County, was killed quite suddenly on the morning of July 31 when he attempted to throw the switch on a 22,000-volt circuit at the substation after he had put in a new fuse. Artificial respiration was given and later a pulmotor from the Hope Natural Gas Co., office was used, but without success. Mr. Lough had been in the employ of the traction company as superintendent of the Mannington district since 1918 and before that had served the company in other capacities for four years.

Society Affairs

The American Institute of Mining and Metallurgical Engineers will start their 128th annual meeting in Toronto on Aug. 20, then take inspection trips to the various near-by mines, resuming the meeting at Quebec on Aug. 28 and finally winding up the meeting at Montreal on Aug. 30.

Business Notes

The Heine Boiler Co., St. Louis, Mo., announces the following changes in its sales organization: George F. Murphy, having completed the reorganization of the New York office, has taken charge of the Philadelphia territory, with headquarters in the Pennsylvania Building; Harold P. Childs, formerly a special representative of the General Electric Co., New York City, has become associated with the company as manager of the New York office with headquarters at No. 11 Broadway.; J. R. Fortune, manager of the Detroit office has assumed the additional charge of the territories formerly covered by the Pittsburgh and Cleveland offices. The Cleveland office has been discontinued.

Coming Conventions

American Chemical Society, Dr. Charles L. Parsons, 1709 G St. N. W., Washington, D. C. Convention at Milwaukee, Wis., Sept. 10-14.

American Institute of Electrical Engineers, F. L. Hutchinson, 29 West 39th St., New York City. Pacific Coast Convention at Del Monte, Calif., Oct. 2-5.

American Institute of Mining and Metallurgical Engineers; F. F. Sharpless, 29 West 39th St., New York City. 128th annual meeting at Toronto, Canada, Aug. 20, Quebec, Aug. 27, Montreal, Aug. 30.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 3-6.

American Society of Refrigerating Engineers, William H. Ross, 35 Warren St., New York City. Nineteenth Annual Convention at New York City, Dec. 3-5.

Association of Iron & Steel Electrical Engineers; J. F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Iron and Steel Exposition at Buffalo, N. Y., Sept. 24-28.

Illuminating Engineering Society, H. E. Mahan, Schenectady, N. Y. Convention at Fort William Henry Hotel, Lake George, N. Y., Sept. 24-28.

International Union of Steam and Operating Engineers; Dave Evans, 6334, Yale Ave., Chicago, Ill. Annual convention at Detroit, Sept. 10-15.

National Association of Practical Refrigerating Engineers; Ed. H. Fox, 914-25 East Jackson Blvd., Chicago. Fourteenth Annual Convention at Memphis, Dec. 12-16.

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Buffalo, N. Y., Sept. 10-15. Annual conventions and exhibitions of the State Associations scheduled as follows: **Pennsylvania,** at Buffalo, Sept. 9-10; J. N. Calvert, Crafton Sta., Pittsburgh, Pa. **New York,** at Buffalo, Sept. 9-10; W. T. Meinzer, Third St., near Warburton, Bayside, L. I., N. Y.

National Safety Council, W. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Twelfth annual congress at the New Statler Hotel, Buffalo, N. Y., Oct. 1-5.

New England Association of Commercial Engineers; James F. Morgan, 53 Devonshire St., Boston, Mass. Power Show at Mechanics Bldg., Boston, Mass., Oct. 29-Nov. 3.

The New England Water Works Association; Frank J. Gifford, 715 Tremont Temple, Boston, Mass. Annual Convention at Burlington, Vermont, Sept. 18-21.

National Exposition of Power and Mechanical Engineering; Charles F. Roth, Room 1102, Grand Central Palace, New York City. Power Show, Dec. 3-8.

Society of Naval Architects and Marine Engineers, Daniel H. Cox, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 8-9.

Trade Catalogs

Ball Bearings, Strom—U. S. Ball Bearing Manufacturing Co., Chicago, Ill. Price list covering single and double-row radial bearings, adapter-type radial bearings, angular-contact bearings and thrust bearings.

Steam Plant Instruments—C. J. Tagliabue Manufacturing Co., 18-88 33rd St., Brooklyn, N. Y. Catalog 640-A lists, describes and illustrates Mono flue-gas analysis recorders, industrial thermometers for steam plants and refrigeration use, expansion steam dial thermometers, recording and dial indicating thermometers, recording pressure gages, mercurial vacuum gages, siphon gages, barometers, etc.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	July 30, 1923	Aug. 6, 1923
Pool 1,	New York	$3.25@3.50	$3.00@3.50
Smokeless,	Columbus	2.75@3.25	2.75@3.25
Clearfield,	Boston	2.00@2.75	2.00@2.75
Somerset,	Boston	2.25@3.00	2.25@3.00
Kanawha,	Columbus	1.75@2.00	1.75@2.00
Hocking,	Columbus	1.75@2.00	1.75@2.00
Pittsburgh No. 8	Cleveland	1.75@1.90	1.85@2.00
Franklin, Ill.	Chicago	2.75@3.00	2.75@3.00
Central, Ill.	Chicago	2.00@2.25	2.00@2.25
Ind. 4th Vein,	Chicago	2.50@2.75	2.50@2.75
West Ky.,	Louisville	1.35@1.85	1.35@1.85
S. E. Ky.,	Louisville	1.50@2.00	1.50@2.00
Big Seam,	Birmingham	1.75@2.15	1.75@2.25

FUEL OIL

New York—Aug. 9, light oil, tank car lots, 28@34 deg. Baumé, 4c. per gal.; 36@40 deg. 4¼c. per gal., f.o.b. Bayonne, N. J.

Chicago — Aug. 6, 24@26 deg. Baumé, $1.97 per bbl.; 32@36 deg., $2.27 per bbl., tank cars.

St. Louis—July 31, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.65 per bbl.; 26@28 deg., $1.70 per bbl.; 28@30 deg., $1.80 per bbl.; 32@36 deg., gas oil, $2.10 per bbl.; 36@40 deg., distillate, $2.30 per bbl.

Pittsburgh—July 31, f.o.b. local refinery, 30@34 deg., fuel oil 4⅝c. per gal.; 36@40 deg., fuel oil, 5c. per gal.; 34 deg., neutral 7¼c. per gal.

Dallas—Aug. 7, f.o.b. local refinery, 26@30 deg., $1.38 per bbl.

Cincinnati—Aug. 9, tank car lots f.o.b. local refinery, 26@30 deg. Baumé 4½c. per gal.; 30@32 deg., 4¾c. per gal.; 38@42 deg., distillate, 6c. per gal.

New Plant Construction

PROPOSED WORK

Ark., McGehee—The city, Bd. of Comrs., c/o Arkansas-Louisiana Highway Office, will receive bids until Aug. 17 for the construction of 6 to 36 in. sanitary sewer, pumping stations and disposal plant, in Sanitary Dist. 1. Cost between $90,000 and $100,000. H. Phillips Eng. Co., Paragould, Engrs.

Calif., Glendale—The Glendale Hotel Co., Inc., is having plans prepared for the construction of a 5 story, 103 x 150 ft. hotel on California St. and Brand Blvd. Estimated cost $300,000. A. F. Priest, 716 Fay Bldg., Los Angeles, Archt. Equipment detail not reported.

Calif., Glendale—A. G. Lindley & C. Selkirk, Archts., Amer. Bank Bldg., Los Angeles, are receiving bids for the construction of a 5 story apartment hotel on East Broadway and Glendale Ave., here, for the Ambrosini Hotel Co., c/o Archts. Equipment detail not reported. Noted Apr. 24.

Calif., Los Angeles—A. C. Blumenthal, Loew State Bldg., plans to build an 8 or 9 story store and loft building on Broadway near 9th St. Cost will exceed $500,000. Engineer or architect not selected.

Calif., Los Angeles—The Methodist Hospital Assn. is having plans prepared for the construction of a hospital, consisting of a 5 story, 37 x 163 ft. main building and a 4 story, 80 x 136 ft. nurses' building, on Grand Ave. Estimated cost $500,000. A. W. Rea and C. E. Garstang, Trust & Savings Bldg., Los Angeles, Archts. Equipment detail not reported.

Calif., Los Angeles — Walker & Eisen, Archts., Pacific Finance Bldg., are receiving bids for the construction of a 13 story, 55 x 168 ft. store and office building on 8th and Olive Sts., for the Eighth & Olive Holding Co. Estimated cost $700,000. Equipment detail not reported.

Calif., Los Angeles — Walker & Eisen, Archts., Pacific Finance Bldg., are receiving bids for the construction of a 12 story, 120 x 137 ft. store and office building on Hollywood Blvd. and Vine St. for the Taft Realty Co., 5751 Hollywood Blvd. Estimated cost $850,000. Equipment detail not reported. Noted June 5.

Conn., New Britain—The Bd. of Health is in the market for complete refrigerating machinery for municipal slaughter house. Estimated cost $11,000. J. D. Williams, City Engr.

D. C., Bellevue—The Bureau of Yards & Docks, Navy Dept., Wash., plans to build a barracks, garage and generating building, here. Estimated cost $25,000.

Fla., Jacksonville—The City Comn. will soon award the contract for the construction of extension to Talleyrand generating station building and machinery foundations; Riverside substation; Enterprise substation, etc. Scofield Eng. Co., Commercial Trust Bldg., Engrs.

Fla., Ocala—The city voted $25,000 bonds for extension to sewer system, including disposal plant and installation of pump.

Ill., Decatur—The Illinois Light & Power Co., 1547 Merchants Bank Bldg., Chicago, plans to build a power plant on Lake Decatur, here. Estimated cost $5,000,000. A. Lucas, Ch. Engr.

Ind., Jeffersonville — The Interstate Public Service Co., 510 Bd. of Trade Bldg., Indianapolis, a subsidiary of the Middle West Utilities Co., 72 West Adams St., Chicago, plans to build a steam power plant, about 30,000 kw., on the Ohio River, near here. Estimated cost $3,000,000.

Kan., Scammon—The City Water Plant, M. Scowden, Supt., will soon change from steam to electric power.

Kan., Topeka—The Illinois Power & Light Co., Illinois Merchants Bank Bldg., Chicago, A. Lucas, Ch. Engr., is having plans prepared for the construction of a generating plant, here. Estimated cost $3,000,000. W. A. Baehr, 232 South Clark St., Chicago, Engr.

Ky., Louisville—J. H. Cochran, 210 Keller Bldg., is in the market for one 100 kw., 125 volt, d.c. generator, about 650 r.p.m.

Md., Salisbury—The B. K. Gibson Co., Archts., 624 South Dearborn St., Chicago, Ill., will receive bids until Aug. 28 for the construction of a 4 and 5 story, 64 x 106 ft. hotel for the Wisconsin Hotel Co., here. Estimated cost $250,000. Equipment detail not reported.

Mass., Boston—The New England Power Co., 50 Congress St., H. I. Harriman, Pres., plans to spend $10,910,000 for street railway extension throughout Massachusetts and the construction of a large generating plant at Davis Bridge (Whitingham P. O.), Vt. The capacity of company will be increased about 136,000,000 kw. hours per year. $5,500,000 worth of bonds will be issued.

Mich., Iron River—The Peninsular Power Co., 102 North Carroll St., plans to build a 44 x 60 ft. Diesel oil driven engine power station. Estimated cost $250,000. Engineer or architect not selected.

Minn., Caledonia—The Houston County Drainage & Conservancy Dist. 1, plans to build a levee and pumping station. Estimated cost $428,000. Central States Eng. Co., 602 Laurel Bldg., Muscatine, Ia., Engrs.

Miss., Booneville — The city is having preliminary survey made for the installation of a pumping plant; settling basin and reservoir; 6 and 8 in. distribution main; fire hydrants, etc. Estimated cost $25,000. A. H. Beard, 616 Title Guaranty Bldg., St. Louis, Mo., Engr.

Mo., St. Louis—The Industrial Loan Co., 714 Chestnut St., is having preliminary plans prepared for the construction of a 10 story, 62 x 85 ft. office building on 9th and Chestnut Sts. Estimated cost $1,000,000. Private plans.

Mo., St. Louis—The Roxana Petroleum Co., is having plans prepared for the construction of forty gasoline service stations, two large supply houses, including storage tanks, pumping machinery, etc. Cost between $350,000 and $1,000,000. Five stations to cost $3,500 each will be started immediately, three to cost $6,000 will be built by day labor. The supply stations will cost from $100,000 to $150,000 each. Private plans.

N. J., Englewood—The Englewood Hospital Assn. is having plans prepared for the construction of a hospital. Estimated cost $1,000,000. Crow, Lewis & Wick, 200 5th Ave., New York, Engrs. and Archts. Equipment detail not reported.

N. J. Paterson—Crow, Lewis & Wick, Engrs. and Archts., 200 5th Ave., New York, will receive bids until Aug. 15 for the construction of a 4 story hospital on Market St., here, for the Paterson Genl. Hospital. Estimated cost $400,000. Equipment detail not reported. Noted Sept. 26, 1922.

N. J., Trenton—The City Comn., A. G. Howell, Acting City Clk., will receive bids until Aug. 17 for one complete unit for water department to consist of one 15 hp. 1,150 r.p.m., 230 volt, compound wound Allis-Chalmers motor, together with speed regulator with armature and field control, direct connected to single stage, double suction, split casting Allis-Chalmers centrifugal pump, capacity of unit 1,000 g.p.m. under 40 ft. head. A. Bugbee, City Hall, Engr.

N. Y., Brooklyn—The Bikur-Cholim Hospital, Lafayette and Sumner Aves., will soon receive bids for the construction of a hospital. Estimated cost $1,000,000. A. Weiser, 9 West 48th St., New York, Engr. and Archt. Equipment detail not reported. Noted July 17.

N. Y., Coney Island (Brooklyn P. O.)—The Seagate Hotel & Bath Corp., c/o R. H. Segal, Archt., 110 West 40th St., New York, is having plans prepared and will soon receive bids for the construction of a 13 story hotel and bath house on Surf Ave. and 24th St., here. Estimated cost $1,000,000. Equipment detail not reported.

N. Y., New York—M. Blumenstock, c/o Shampan & Shampan, Engrs. and Archts., 188 Montague St., Brooklyn, is having plans prepared for the construction of a loft building at 250 West 37th St., here. Estimated cost $1,000,000. Equipment detail not reported.

N. Y., New York—The Jewish Maternity Hospital, 270 East Broadway, plans to build a 75 x 125 ft. hospital on 5th Ave. and 108th St. Estimated cost $750,000.

N. Y., New York — The Professional Offices, Inc., c/o Ewing & Allen, Archts., 101 Park Ave., is having plans prepared and will soon receive bids for the construction of an 11 story office building at 121 East 60th St. Estimated cost $900,000. Equipment detail not reported.

N. C., Fayetteville—The Fayetteville Hotel Co. is having plans prepared and will receive bids about Oct. 2 for the construction of an 8 story, 90 x 115 ft. hotel. Estimated cost $250,000. W. G. Rogers, Trust Bldg., Charlotte, Archt. Equipment detail not reported. Noted May 8.

N. C., High Point—The Mayor and City Council will receive bids until Aug. 22 for the construction and equipment of three sewerage pumping stations, including receiving reservoir and duplicate motor driven pumping units. A. E. Taplin, Engr.

N. C., Kinston—Caswell Training School, D. C. B. McNairy, Supt., will receive bids until Aug. 20 for the construction of a hospital, boys' industrial, girls' industrial and cold storage buildings, etc. Mechanical equipment under separate contract. H. A. Underwood, Jr., Bldg. Com., Raleigh, Engr. Noted May 29.

N. C., Raleigh—The City Comrs. will soon receive new bids for pumping equipment, concrete surge tank and intake for Lake Raleigh. Former bids rejected. Estimated cost $40,000. Contract was awarded for the construction of four filtering plants, 500,000 gal. capacity each; conditioning of present seven filters; coagulating basin, filter tubs and buildings, to Tucker & Laxton, Realty Bldg., Charlotte. This work will increase capacity of filtering plant from 3,500,000 to 5,000,000 g.p.d. Estimated cost $124,178. W. C. Olsen, Kinston, Engr. Noted July 17.

N. C., Wilmington—Carter's Production Wks., 210 South Front St., dealer and manufacturer of machinery, O. Carter, Mgr., is in the market for a 100 hp. slide valve throttling governor engine, complete (used).

Ohio, Cleveland — The Independent Towel Suppy Co., 1822 Central Ave., S. Miller, Mgr., has had plans prepared for the construction of a 1 story, 35 x 80 ft. boiler house. Estimated cost $50,000. Christian, Schwarzenberg & Gaeda, 1900 Euclid Ave., Cleveland, Archts.

Ohio, Cleveland — I. Margolin, 2496 Derbyshire Rd., Cleveland Heights (Warrensville P. O.), is having plans prepared for the construction of a 6 story apartment hotel, including steam heating system, at 3701 Euclid Ave., here. Estimated cost $350,000. M. Weis, 617 Union Bldg., Cleveland, Archt.

Okla., Holdenville—The city will soon hold an election to vote on $85,000 bonds for enlarging filter plant, new pumping equipment and water main extensions. McIntosh Co., 1st Natl. Bldg., Oklahoma City, Engrs.

Okla., Picher—The Cortez Mining Co., W. Landum, Purch. Agt., is in the market for a 150 hp. steam boiler.

Okla., Ramona—The city holds an election Aug. 14 to vote on $50,000 bonds for water main extensions, two motor driven triplex pumps and wells. E. W. Baker, 1st Natl. Bank, Oklahoma City Engr.

Ore., Klamath—The Bureau of Reclamation, D. W. Davis, Comr., will receive bids until Sept. 12 for the construction of the Gerber Dam, including about 10,000 cu.yd. of excavation and the placing of 9,500 cu. yd. of concrete.

Pa., Phila.—Wallace & Werner, Archts., 1012 Walnut St., have had plans prepared and will receive bids for the construction of a 6 story, 150 x 190 ft. apartment house on the city line at Overbrook. Separate contracts will be awarded including heating and ventilating system. Estimated cost $500,000. Owner's name withheld.

Pa., Pittsburgh — The Salvation Army, 324 Diamond St., will have revised plans prepared and receive bids about Oct. 1 for the construction of an 8 story, 63 x 120 ft. hotel and welfare building on 2nd Ave. and Cherry Way. Estimated cost $500,000. T. Pringle, Renshaw Bldg., Pittsburgh, Archt. Equipment detail not reported. Former bids rejected. Noted July 17.

Pa., Pittsburgh—The A. W. Smith Co., Keenan Bldg., plans to build a 4 story, 110 x 171 ft. store and office building on 6th and Smithfield Sts. Estimated cost $1,000,000. Engineer or architect not selected.

Tenn., Hohenwald—The city, A. J. Petway, Mayor, is having surveys made for the construction of a hydro-electric plant. Noted Mar. 20.

Tenn., Knoxville — The Duncan Mchy. Co., Dempster Bldg., 721 North Central Ave., machinery dealer, J. G. Duncan, Purch. Agt., is in the market for a 150 hp. locomotive or portable for 125 to 150 lb. steam pressure, a 3 to 6 hp. vertical stationary engine (used) and a 20 hp. locomotive Scotch marine boiler, or 100 to 150 hp.

Tenn., Lawrenceburg—The city voted $80,000 bonds for the construction of a dam and power plant at Shoak Creek. Freeland, Roberts & Co., Independent Life Bldg., Consult. Engrs. Noted June 26.

Tenn., Nashville—The Davidson County Asylum, J. F. Gaffney, 333 4th Ave., N., Chn., will receive bids until Aug. 16 for a complete ice making machine, including crane, coils, ice cans, storage tank, agitation, etc.

Tex., Ballinger—Coke Runnels Water Improvement Dist. 1, c/o J. W. Gaines, San Antonio, will hold an election Aug. 18 to vote on creation of district and financing the construction of a dam, 2,000 ft. long, 100 ft. high, to provide lake, etc., to irrigate and reclaim 200,000 acres. Estimated cost $4,500,000. C. C. Holder, Bronte, Engr. Noted July 31.

Tex., Corsicana—The Navarre Ice Co. is having plans prepared for the construction of an ice plant on South 12th St. along tracks of Cotton Belt R.R. Estimated cost $100,000. Private plans.

Tex., Fort Worth—The Crystal Ice Co., 301 East Magnolia St., plans to build an ice plant on Arlington Heights. Estimated cost $60,000.

Va., Norfolk—The Taylor-Parker Co., Water St. and Commercial Pl., is in the market for 150 hp. return tubular high pressure boilers, also all sizes Erie City economic boilers.

W. Va., Wellsburg—The City Water Bd., E. A. Sheets, Pres., will receive bids until Aug. 15 for furnishing and installing a 2,000,000 gal. motor driven centrifugal low-lift pump; a 2,000,000 gal. motor driven centrifugal high-lift pump with appurtenances; division and lining of dry well; piping. The work will be divided into two parts, mechanical and structural. Bids will be received on either one or both parts. Hudson & Myron, 808 Wabash Bldg., Pittsburgh, Pa., Engrs. Noted Mar. 13.

Wis., Barron—The city plans to build a hydro-electric generating plant. Estimated cost $50,000.

Wis., Brownsville—The Brownsville Canning Co. is having plans prepared for the construction of a 1 story, 60 x 90 ft. canning plant. Estimated cost $40,000. Private plans. The owner is in the market for power machinery, motors, etc.

Wis., Madison—M. B. Allison, 119 Monroe Ave., is in the market for refrigeration machinery and plant, either ammonia or brine.

Wis., Madison—A. J. Huebbe, 525 State St., is having plans prepared for the installation of a steam heating plant and boiler in store building. P. M. Homer, Pioneer Bldg., Madison, Engr.

Wis., Manitowoc—The New Hotel Corp., c/o T. W. Gray, 526 North 8th St., is having preliminary plans prepared for the construction of a 5 story hotel on 10th and Washington Sts. Estimated cost $500,000. M. Tullgren & Sons Co., 425 East Water St., Milwaukee, Archts.

Wis., Milwaukee—The city, Central Bd. of Purchases, received bids for equipment for Riverside pumping station, 200 g.p.m. sump pump from C. W. Miller, 209 Grand Ave., Milwaukee, $2,837; coal and ash handling equipment, Stephens Adamson Mfg. Co., Ridgeway St., Aurora, Ill., $41,200; Link Belt Co., 910 South Michigan Ave., Chicago, $44,800; Chain Belt Co., 736 Park St., Milwaukee, $50,100.

Wis., Milwaukee—The Milwaukee Electric Ry. & Light Co., 2nd and Sycamore Sts., is having plans prepared for the construction of a 50 x 70 ft. addition to its boiler house, including boilers, stokers and stack, on Edison Ave. Estimated cost $65,000. J. Anderson, Ch. Engr.

Wis., Waukesha—Carroll College, W. A. Ganfield, res., is receiving bids for a central steam heating plant. Estimated cost $25,000. H. C. Haeuser, 445 Milwaukee St., Milwaukee, Engr.

British Columbia—The Canadian Pacific Ry., Windsor Sta., Montreal, Que., is having estimates and surveys made for the construction of dams and water power development on its mountain division, here. J. M. R. Fairbairn, Ch. Engr.

Ont., Acton—The Hydro-Electric Power Comn., 190 University Ave., is in the market for three 100 hp. transformers for substation, here. F. A. Gaby, Ch. Engr.

Que., Carillon—The Natl. Hydro-Electric Co., Ltd., Montreal, plans to raise the dam on the Ottawa River, here, from 94 to 133 ft. The project is before the Quebec Legislature. Estimated cost $30,000,000.

Que., Montreal—The Natl. City Co., St. James St., N. L. C. Mather, Pres., plans to build a 10 story office building. Estimated cost $600,000.

Australia, Melbourne—The State Electricity Comn. of Victoria, 22-32 William St., R. Liddelow, Secy., will receive bids until Oct. 6 for 22,000 volt insulators for Morwell Power Scheme.

CONTRACTS AWARDED

Calif., Los Angeles—The May Co., c/o A. C. Martin, Archt., Higgins Bldg., awarded the contract for the construction of a 9 story department store on Hill St., to MacDonald & Kahn, Loew State Bldg., Los Angeles. Estimated cost $1,000,000. Equipment detail not reported.

Calif., Los Angeles—A. E. Mortimer and G. Witte, Chapman Bldg., awarded the contract for the construction of a 5 story hotel on 2nd and Figueroa Sts. to the Los Angeles Bldg. & Constr. Co., Marsh-Strong Bldg. Estimated cost $267,000. Equipment detail not reported.

Every one of these items is reported by our authorized correspondents who are instructed to verify every item sent in. This free weekly service is published in the interests of the buyer and the seller, to bring them together and get machinery moving.

Everything possible is done to insure authenticity and timeliness.

Your co-operation is invited in helping us maintain this service at the highest efficiency.

BUSINESS NEWS DEPARTMENT
Tenth Ave. at 36th St., New York

Calif., San Francisco — The Office of United States Engr. awarded the contract for two electric motor and controlling appliances to the General Electric Co., Rialto Bldg., San Francisco. Estimated cost $9,381. Noted July 3.

Ill., Chicago—D. S. Klafter, Archt., 64 West Randolph St., awarded the contract for the construction of a 2 story, 125 x 126 ft. theatre, store and office building at 3940-46 Fullerton Ave., to Thogersen & Erickson, 4804 North Kedzie St., Chicago. Estimated cost $750,000. Steam heating system will be installed. Noted July 2.

Ind., Fort Wayne—Thieme Bros., Knitters Ave., awarded the contract for the construction of a 1 story dye house, including heating and ventilating system, also 100,000 gal. fire protection reservoir; 48 x 53 ft. boiler house with hand stokers, three 150 hp. H. E. T. boilers, also provision for fourth boiler; pump and fan rooms, water softening capacity 40,000 gal. and a 20,000 gal. storage tank, to Lockwood, Greene & Co., 38 South Dearborn St., Chicago.

Ia., Davenport — The Union-Davenport Trust & Savings Bank awarded the contract for the construction of a 7 story bank and office building on 3rd and Bradley Sts. to Hoggson Bros., 485 5th Ave., New York, N. Y. Estimated cost $850,000. Equipment detail not reported.

Ky., Louisville—The Office of the United States Engineer, P. O. Box 72, awarded the contract for furnishing one deep well pump, double stroke, 8 in. drop pipe, for Dam 44, to the Belknap Hardware & Mfg. Co., 2nd and Washington Sts. Estimated cost $2,230. Noted July 24.

Minn., Willmar—The city awarded the contract for waterworks improvements, to J. H. Olsen & Co. and B. Benson, Willmar. Estimated cost, reservoir $14,494; pumping equipment $21,370. Noted July 17.

Mo., St. Louis—The Union Electric Light & Power Co., 12th and Locust Sts., awarded the contract for the construction of a 1 story, 53 x 65 ft. substation power plant at 3141-45 Hickory St., to the Fruin-Colnon Constr. Co., Merchants-Laclede Bldg., St. Louis. Estimated cost $30,000. Equipment will be purchased separately.

N. Y., Arverne (Far Rockaway P. O.)—The Bd. Educ., 500 Park Ave., New York, awarded the contract for heating, ventilating and temperature regulating apparatus for P. S. 42, here, to the Raisler Heating Co., 129 Amsterdam Ave. Estimated cost $85,200. Noted July 24.

N. Y., Brooklyn — The Bd. Educ., 500 Park Ave., New York, awarded the contract for heating, ventilating and temperature regulating apparatus for P. S. 190 on Sheffield Ave., here, to the Raisler Heating Co., Inc., 129 Amsterdam Ave., New York, $83,990; for P. S. 100 near Sheepshead Bay Rd. to Gillis & Geoghegan, Inc., 537 West Broadway, New York, $84,790. Noted July 24.

N. Y., Brooklyn—Borden's Farm Products Co., 110 Hudson St., awarded the contract for the construction of a 4 story pasteurization and distribution plant on 3rd Ave. to the Perry Reed Co., 348 West 14th St., New York. Estimated cost $350,000.

N. Y., Elmhurst (Flushing P. O.)—Lodge 878, B. P. O. E., 226 Mott Ave., Long Island City, awarded the contract for the construction of a 4 story, 75 x 116 ft. lodge building on Queens Blvd., here, to G. H. McEntee & Co., 103 Park Ave., New York. Estimated cost $800,000. Equipment detail not reported. Noted July 12, 1921.

N. Y., Mineola—The Nassau Hospital awarded the contract for the construction of a 5 story hospital to the Wills Eagelholf Co., 101 Park Ave., New York. Estimated cost $350,000. Equipment detail not reported. Noted Nov. 7, 1922.

N. Y., New Brighton—The Bd. Educ., 500 Park Ave., New York, awarded the contract for heating, ventilating and temperature regulating apparatus for Curtis High School, here, to D. J. Rice, 405 Lexington Ave., New York. Estimated cost $39,770. Noted July 24.

N. Y., New York—Starrett Bros., Inc., 101 Park Ave., will build by separate contracts, a 14 story apartment house on Park Ave. and 65th St. Equipment detail not reported.

Tex., Dallas—The Dallas Power & Light Co., Interurban Bldg., awarded the contract for 15,000 kw. extension breeching plate work to the Wyatt Metal & Boiler Wks., West Dallas Pike, Dallas. Estimated cost $25,000.

Wis., Madison—The University of Wisconsin, M. E. McCoffery, Secy., will build by day labor a 1 story, 50 x 80 ft. heating plant. Estimated cost $88,000. Contract has been awarded for two boilers to the Babcock & Wilcox Co., 85 Liberty St., New York, $28,542; two stokers to the Cokal Stoker Co., 341 East Ohio St., Chicago, $12,812.

Wis., Milwaukee—The Pittsburgh Plate Glass Co., 205 Lake St., awarded the contract for the construction of a 2 story, 67 x 84 ft. power house to the Dahlman Constr. Co., 456 Broadway, Milwaukee. Estimated cost $70,000.

Wis., North Milwaukee—The Milwaukee Electric Ry. & Light Co., awarded the contract for the construction of a 40 x 65 ft. substation to the Dahlman Constr. Co., 456 Broadway, Milwaukee. Estimated cost $25,000. The owner will purchase transformers. R. H. Pinkley, c/o owner, Engr. J. Anderson, Plant Engr. Noted Aug. 7.

Ont., Campbellford — The Hydro-Electric Power Comn. of Ontario, 190 University Ave., Toronto, awarded the contract for work in connection with hydro-electric power development, including excavation and power house, at Dam 8, Trent Valley Canal, here, to the Sinclair Constr. Co., Ltd., Excelsior Life Bldg., Toronto. Estimated cost $250,000. The owner will purchase turbines, gates, crane, switches, generators, arresters, buses, etc. Plans are being prepared and bids will soon be received for Dam 9. Estimated cost $500,000. F. A. Gaby, Ch. Engr. Noted May 22.

Ont., Kitchener—The Sisters of St. Joseph awarded the general contract for the construction of a 3 story hospital on Queens Park Ave., to the W. M. Sutherland Co., Ltd., 43 Adelaide St. W., Toronto, $258,000. Watt & Blackwell, Archts., Bank of Toronto Bldg., London, will award the contract for steam heating system. Noted June 26.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

Declines—Raw linseed oil declined 8c. in New York; 9c. in Cleveland and 14c. per gal. in Chicago, during month. Minimum on structural and boiler rivets, 10c. per 100 lb. lower at Pittsburgh mill. Babbitt metal, all grades, down 4c.@5c. per lb. in New York and ½c.@3c., in Cleveland. Cotton waste declined ¼c. in Chicago and washed white wiping cloths, ½c. per lb. in New York. Rubber hose and belting prices slightly lower than month ago.

Advances—Cold-finished steel shafting, $4.55 in Chicago, against $4.30; flats, squares, etc., $5.05, compared with $4.80 per 100 lb., one month ago. Discounts on low-pressure pipe covering slightly lower.

POWER-PLANT SUPPLIES

HOSE—

Fire		50-Ft. Lengths
Underwriters' 2½-in., coupled		53c. per ft.
Common, 2½-in., 3-ply		$1.00 per ft. list less 40–10–5%

Air		
¾-in., per ft.	3-ply $0.33	4 ply $0.25

Steam—Discounts from List

First grade....40–5% Second grade....45% Third grade.....50%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition..... 60–5% Best grade..... 50–10–5%

LEATHER BELTING—List price, 2c. per sq. in., per ply.

Grade	Discount from list
Medium	30–10%
Heavy	20–5–2½%

RAWHIDE LACING { For cut, best grade, 40%, 2nd grade, 50%. For laces in sides, best, 48c. per sq.ft.; 2nd, 43c. Semi-tanned: cut, 40%; sides, 48c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.70
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.80
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.70@ $2.80 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.64 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York Current	Cleveland	Chicago
White	10.00@13.00	15.00	11.00
Colored	8.00@13.00	12.00	8.00

WIPING CLOTHS—Jobbers' prices, in cents per lb., as follows:

	13½ x 13½	13½ x 20½
Chicago	10.00	13.00
New York	10.25	.....
Cleveland	$36.00 per M.	$52.00 per M.

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$1.05	$1.18	$1.14

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	14.00	12.50	15.50	14.00
White	14.00	12.50	14.00	12.50

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅛ and smaller	40%	50-10%	60%
Tinned	40%	50–10%	4½c. per lb. net

Structural rivets, ½, ⅝, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.

New York.....$4.40 Chicago.....$3.75 Pittsburgh.....$3.15@3.25

Boiler rivets, same sizes:

New York.....$4.50 Chicago.....$3.85 Pittsburgh.....$3.25@3.35

REFRACTORIES—Prices in carlots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$50@55
Chrome cement, 40@ 50% Cr_2O_3, in bulk	net ton	27@32
Chrome cement, 40@ 50% Cr_2O_3, in sacks	net ton	31@36
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	92.00@96.20
Silica brick: Mt. Union, Pa.	per M	45.00@46.50
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	48@55
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	45@47
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	45@47
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	43@50
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	42@45
Chrome ore crude, 40@ 50%	net ton	20.00@25.50

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
(83% tin)	52.00	48.00	40.00
(35% tin)	25.00	17.00	16.00

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.40	$3.90	$4.55
Flats, square and hexagons, per 100 lb. base	4.90	4.40	5.05

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Galv.	Inches	Iron Black	Galv.
1 to 3	62	50½	¼ to 1¼	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½ to 4	26	11
7 and 8	56	43½	4½ to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	¼ to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$0.23
1¼	.....	.....	.25
1½	.....	.....	.22
1¾	$0.26	$0.29	.23
2	.20	.25	.21
2¼	.23	.29	.23
2½	.24	.33	.28
2¾	.....	.....	.....
3	.30	.41	.32
3½	.32	.47	.35
3½	.34	.51	.37
4	.43	.64	.47

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per lineal foot based on stock lengths. If cut to special engths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

1¼ in. to 2 in. diameter, 5c. per cut. 2½ in. diameter, 7c. per cut
2¾ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3½ in. to 4 in. diameter, 10c.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$ 43.00 (net)	$ 84.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

		Lead Covered
Less than coil lots	30%	15%
Coils to 1,000 ft.	35%	20–10%
1,000 to 5,000 ft.	40%	30%
5,000 ft. and over	45%	35%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$61.10	$66.16	$9.90	$11.03	$5.74	$6.16
¾	79.20	84.95	13.00	14.49	8.18	8.78
1	112.06	122.19	19.26	21.46	10.65	11.42
1¼	151.62	165.31	25.65	28.33	14.76	15.78
1½	181.28	197.67	34.19	37.77	18.23	19.47
2	248.90	265.94	62.70	69.24	24.29	25.97
2½	385.50	420.48	102.58	11.33	34.71	37.10
3	504.29	548.81	273.40	302.12	51.66	55.63
3½	633.86	688.65	604.03	667.15	69.41	74.19
4	772.62	838.59	697.06	770.99	86.76	92.73

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.10	D. P. D. B.	$0.32
D. P. M. L.	.16	T. P. S. B.	.30
T. P. M. L.	.24	T. P. D. B.	.42
D. P. S. B.	.18		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.39	$1.00	$2.10
T. P. M. L.	.60	1.47	2.80
D. P. S. B.	.49	1.25	.....
T. P. S. B.	.92	2.10	.....
D. P. D. B.	.89	2.46	.....
T. P. D. B.	1.57	4.20	.....
T. P. to D. P. D. B.	1.05	2.88	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$23.00
No. 16 cotton reinforced heavy	29.00
No. 18 cotton reinforced light	19.50
No. 16 cotton reinforced light	22.50
No. 18 cotton Canvasite cord	17.00
No. 16 cotton Canvasite cord	19.25

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.20	3-amp. to 30-amp.	100	$0.40
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100-amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 55%; 1-5th to standard package, 60%; standard package, 65%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:
- Broken carton 5%
- Unbroken carton but less than std. pkg. 22%
- Std. pkg. 40%

Discount Without Contract—Renewals:
- Less than std. pkg. ..... Net list
- Standard package 40%

Discount With Contract—Fuses:
- Broken cartons 10%
- Unbroken cartons but less than standard package 26%
- Standard package 42%

Discount With Contract—Renewals:
- Less standard package ..... Net list
- Standard package 42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.70
0-30 ampere, less than standard package	3.00

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.32	$0.37	120	75	$0.55	$0.60	60
15	.32	.37	120	100	.70	.75	24
25	.32	.37	120	150	.90	.95	24
40	.32	.37	120	200	1.15	1.25	24
50	.32	.37	120	300	1.75	1.85	24
60	.37	.42	120				
				500	2.50	2.65	12
				750	3.75	4.00	8
				1,000	4.25	4.50	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.19
Composition 2-piece attachment plug	.29
Swivel attachment plug	.12

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$ 7.98	$10.39	$12.18	$19.24
12	10.44	13.23	14.97	25.02
10	13.91	17.22	19.23	32.16
8	19.42	22.05	24.69	43.33
6	.....	.....	35.80	.....
4	.....	.....	49.14	.....
2	.....	.....	70.93	.....
1	.....	.....	92.03	.....
0	.....	.....	121.89	.....
00	.....	.....	144.51	.....
000	.....	.....	172.91	.....
0000	.....	.....	211.51	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each	½ In. or Pendant Cap Keyless Each	½ In. or Pendant Cap Pull Each	¾ In. Cap Key Each	¾ In. Cap Keyless Each	¾ In. Cap Pull Each
$0.33	$0.30	$0.55	$0.39	$0.36	$0.61

- Less 1-5th standard package 25%
- 1-5th to standard package 30%
- Standard package 35%

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:
- Less than $25.00 list value 25%
- $25 to $50 list value 30%
- $50 list value or over 35%